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First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette: Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

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Martin, J. F., Agricultural College, Amherst, Mass.
Mason, P. W., Purdue University, Lafayette, Ind.
Matheson, Robert, Cornell University, Ithaca, N. Y.
Maxon, Asa C., Longmont, Colo.
McColloch, J. W., Agricultural Experiment Station, Manhattan, Kan.
McConnell, W. R., U. S. Bureau of Entomology, Hagerstown, Md.
McDaniel, Eugenia, Agricultural College, East Lansing, Mich.
McDonough, F. L., U. S. Bureau of Entomology, Batesburg, S. C.
McLaine, L. S., care of Dominion Entomologist, Ottawa, Canada.
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Moore, Wm., University Farm, St. Paul, Minn.
Morse, A. P., Wellesley, Mass.
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Needham, J. G., Cornell University, Ithaca, N. Y.
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Ness, Henry, Ames, Iowa.
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Niswonger, H. R., Agricultural Experiment Station, Lexington, Ky.
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O'Byrne, F. M., Gainesville, Fla.
Oestlund, O. W., University of Minnesota, Minneapolis, Minn.
Osborn, Herbert T., Hawaiian Sugar Planters Experiment Station, Honolulu, H. T.
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Reed, W. V., Capitol Building, Atlanta, Ga.
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Zappe, Max P., Agricultural Experiment Station, New Haven, Conn.

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Fuller, Claude, Department of Agriculture, Peitermaritzburg, Natal, South Africa.
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Goding, F. W., Guayaquil, Equador, South America.
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Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
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Ritzema Bos, Dr. J., Agricultural College, Wageningen, Netherlands.
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Sajo, Prof. Karl, Gödöllö-Veresegyház, Hungary.
Schoyen, Prof. W. M., Zoölogical Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tryon, H., Queensland Museum, Brisbane, Queenland, Australia.
Urich, F. W., Victoria Institute, Port of Spain, Trinidad, West Indies.
Vermorel, V., Station Viticole, Villefranche, Rhone, France.

American Association of Economic Entomologists
Columbus, Ohio, Dec. 30, 1915

EXPLANATION OF PLATE 1 (*Frontispiece*)

1 M. P. Somes
2 T. J. Headlee
3 A. D. MacGillivray
4 J. G. Sanders
5 H. Ness
6 F. L. Thomas
7 J. M. Aldrich
8 S. B. Fracker
10 G. B. Merrill
11 T. D. Urbahns
12 W. A. Riley
14 Harold Morrison
15 H. F. Dietz
16 Hugh Glasgow
17 Paul S. Welch
18 H. J. Speaker
19 W. A. Osgood
20 N. E. Shaw
21 V. R. Haber
22 F. W. Rane
23 E. F. Phillips
24 Dr. Riley
25 G. M. Bentley
26 W. E. Rumsey
27 A. F. Burgess
28 S. J. Hunter
29 J. Edward Taylor
31 Max Kislink, Jr.
32 V. E. Shelford
33 C. Gordon Hewitt
34 Glenn W. Herrick
35 W. D. Will
36 L. M. Peairs
37 Carl J. Drake
38 E. W. Mendenhall
39 E. P. Felt
40 V. L. Kellogg
41 H. C. Yingling
42 Geo. A. Dean
43 H. E. Evans
44 E. R. King
45 S. W. Bilsing
46 L. O. Howard
47 D. M. DeLong
48 J. S. Houser
49 Adolph Beyer
50 F. H. Lathrop
51 W. L. Chandler
52 W. J. Schoene
53 Herbert Osborn
54 R. S. McKay
55 G. D. Shafer
56 W. T. M. Forbes
57 Ed. Ayres
58 P. B. Wiltberger
59 N. F. Howard
60 Annette Braun
61 R. A. Samuels
62 L. H. Worthley
64 W. P. Hayes
65 Morley Pettit
66 J. H. Merrill
67 Wm. Moore
68 Evelyn Osborn
69 F. A. Fenton
70 W. C. O'Kane
71 F. D. Heckathorn
72 H. S. Watts
73 J. W. McColloch
74 T. H. Parks
75 E. C. Cotton
76 Goey Park Jung
77 J. R. Parker
78 J. W. Chapman
79 H. W. Allen
80 J. S. Hine
81 D. B. Whelan
82 Alvah Petersen
83 R. D. Whitmarsh
84 F. B. Paddock
85 M. W. Blackman
86 C. A. Reese
87 W. E. Evans, Jr.
88 I. L. Bailey
89 C. F. Stiles
90 P. W. Mason
91 E. S. Cogan
92 D. B. Hussey
93 W. H. Larrimer
94 R. W. Leiby
95 H. A. Gossard
96 Joe S. Wade
97 A. W. Plowman
98 J. L. King
99 B. B. Fulton

JOURNAL
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 9 FEBRUARY, 1916 No. 1

Proceedings of the Twenty-eighth Annual Meeting of the American Association of Economic Entomologists

The twenty-eighth annual meeting of the American Association of Economic Entomologists was held in the Botany and Zoölogy Building at the Ohio State University at Columbus, O., December 27 to 30, 1915.

The first session was held at 1.30 p. m., December 27, when annual reports were given and the address of the President was delivered.

The meeting of the section on Apiary Inspection was held at 8.00 p. m., December 27, at the Southern Hotel. The meeting of the section on Horticultural Inspection was held at 8.00 p. m., December 28, in the House of Representatives in the State Capitol and a session on the following morning was held at the State University.

The business proceedings of the Association are given as Part 1 of this report and the addresses, papers and discussions will be found in Part 2.

The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

A large attendance was present at the meeting and the program was varied and very interesting.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President Glenn W. Herrick at 1.30 p. m., Monday, December 27, 1915.

About 150 members and visitors attended the sessions. The following members were present:

C. N. Ainslie, Elk Point, S. D.
Geo. G. Ainslie, Nashville, Tenn.
J. M. Aldrich, Lafayette, Ind.
H. W. Allen, Melrose Highlands, Mass.
I. L. Bailey, Northboro, Mass.
G. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
A. H. Beyer, Washington, D. C.
S. W. Bilsing, College Station, Tex.
M. W. Blackman, Syracuse, N. Y.
A. F. Burgess, Melrose Highlands, Mass.
J. W. Chapman, Forest Hills, Mass.
Mel T. Cook, New Brunswick, N. J.
E. C. Cotton, Elyria, Ohio.
C. R. Crosby, Ithaca, N. Y.
J. J. Davis, Lafayette, Ind.
Geo. A. Dean, Manhattan, Kan.
H. F. Deitz, Indianapolis, Ind.
M. W. Eddy, State College, Pa.
W. E. Evans, Jr., Painesville, Ohio.
H. E. Ewing, Ames, Iowa.
E. P. Felt, Albany, N. Y.
F. A. Fenton, West Lafayette, Ind.
S. B. Fracker, Madison, Wis.
B. B. Fulton, Geneva, N. Y.
Hugh Glasgow, Geneva, N. Y.
W. H. Goodwin, Wooster, Ohio.
H. A. Gossard, Wooster, Ohio.
W. P. Hayes, Manhattan, Kan.
T. J. Headlee, New Brunswick, N. J.
G. W. Herrick, Ithaca, N. Y.
C. Gordon Hewitt, Ottawa, Canada.
J. S. Hine, Columbus, Ohio.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
N. F. Howard, Columbus, Ohio.
S. J. Hunter, Lawrence, Kan.
H. H. Jewett, Lexington, Ky.
V. L. Kellogg, Stanford University, Cal.
J. L. King, Cleveland, Ohio.
Max Kislink, Jr., Washington, D. C.
W. H. Larrimer, Wellington, Kan.
F. H. Lathrop, Geneva, N. Y.
R. W. Leiby, Raleigh, N. C.
A. D. MacGillivray, Urbana, Ill.
P. W. Mason, Lafayette, Ind.
J. W. McColloch, Manhattan, Kan.
E. W. Mendenhall, Clintonville, Ohio.
G. B. Merrill, North Abington, Mass.
J. H. Merrill, Manhattan, Kan.
C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, Raleigh, N. C.
Wm. Moore, St. Paul, Minn.
Wilmon Newell, Gainesville, Fla.
Henry Ness, Ames, Iowa.
F. M. O'Bryne, Gainesville, Fla.
W. C. O'Kane, Durham, N. H.
W. A. Osgood, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
F. B. Paddock, College Station, Tex.
J. R. Parker, Bozeman, Mont.
T. H. Parks, Ashville, Ohio.
Edith M. Patch, Orono, Me.
L. M. Peairs, Morgantown, W. Va.
F. C. Pellett, Atlantic, Iowa.
Alvah Peterson, Urbana, Ill.
Morley Pettit, Guelph, Canada.
E. F. Phillips, Washington, D. C.
W. J. Phillips, Charlottesville, Va.
F. W. Rane, Boston, Mass.
W. A. Riley, Ithaca, N. Y.
A. H. Rosenfeld, Tucuman, Argentina.
A. G. Ruggles, St. Paul, Minn.
W. E. Rumsey, Morgantown, W. Va.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, Lafayette, Ind.
W. J. Schoene, Blacksburg, Va.
G. D. Shafer, East Lansing, Mich.
N. E. Shaw, Columbus, Ohio.
V. E. Shelford, Urbana, Ill.
F. L. Simanton, Benton Harbor, Mich.
M. P. Somes, Mountain Grove, Mo.
H. J. Speaker, Sandusky, Ohio.
J. Edward Taylor, Salt Lake City, Utah.
F. L. Thomas, Auburn, Ala.
James Troop, Lafayette, Ind.
T. D. Urbanus, Washington, D. C.
Joe S. Wade, Wellington, Kan.
F. M. Webster, Washington, D. C.
R. L. Webster, Ames, Iowa.
Don B. Whelan, East Lansing, Mich.
R. D. Whitmarsh, Wooster, Ohio.
G. C. Woodin, East Lansing, Mich.
L. H. Worthley, Boston, Mass.

President Glenn W. Herrick: You will please come to order. The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

At the time of the last Annual Meeting of the Association the membership consisted of 133 active, 212 associate and 52 foreign members, making a total of 397. At that meeting one active member resigned and seven associate members were transferred to the active list. Since the meeting one active member has died and three have been dropped for non-payment of dues. At the time of the meeting two associate members resigned and 66 new associate members were elected. Since that time two have been dropped for non-payment of dues. The present membership is as follows: Active, 135; associate, 267; foreign, 52, making a total of 454.

Since our last meeting Mr. Harry M. Russell, who for a number of years has been employed by the Bureau of Entomology, has been removed by death. Mr. Russell was born in Bridgeport, Conn., March 30, 1882; graduated from the Bridgeport High School in 1901 and from the Massachusetts Agricultural College in 1906. He died at Phoenix, Ariz., June 25, 1915. Mr. Russell was an excellent worker in economic entomology and his loss will be greatly felt.

On August 9–10, 1915, a special meeting of the Association was held at Berkeley, Cal. The meeting was very successful, members attending who are usually unable to be present at the annual meeting. The Secretary attended the meeting and was greatly impressed with the enthusiasm and zeal with which the members in the western states are meeting the many difficult entomological problems which must be solved.

At the Berkeley meeting, several sessions of which were held jointly with the Pacific Coast Association of Economic Entomologists, the desire was expressed by that association to become affiliated with this Association and a committee was appointed to consider the matter. A report of this committee will be found in the October number of the Journal. A recommendation for making a minor modification of the constitution so as to bring this affiliation about is suggested by the committee for action at this meeting.

The finances of the Association have improved since the last annual meeting and at the present time we have a generous surplus on hand. This has been brought about by the slight increase in the amount of dues provided for at the last meeting and also because a considerable portion of the 1916 dues have already been paid.

The Journal of Economic Entomology

The increase in Association dues was coupled with a slight advance in the subscription price of the Journal and this has been very beneficial to that publication. It has been possible to accept more papers for publication and print them more promptly than heretofore. This should be appreciated by the members and subscribers.

During the past year the net increase in the subscription list has amounted to 44. Although there have been many cancellations of foreign subscriptions, there was a net increase of three during the year. The number of subscriptions to the Journal should be still further increased. If the members will interest themselves in new subscribers the list ought to extend very materially.

Association Statement

Balance in Treasury, December 22, 1914		$262.34
By amount received for dues, 1915		631.00
By amount received from Section on Apiary Inspection		3.25
By amount received from interest		14.31
To stenographic report 1914 meeting	$88.32	
Stamps and stamped envelopes	46.51	
Printing announcements, etc.	63.55	
Telegraph and express	5.29	
Miscellaneous supplies	1.00	
Clerical work, Secretary's office	34.92	
One-half salary of Secretary	50.00	
	$289.59	
Balance, December 23, 1915	621.31	
	$910.90	$910.90

Balance deposited as follows:

Melrose Savings Bank	$145.46
Malden National Bank	475.85

Journal Statement

Balance in Treasury, December 22, 1914		$396.41
By amount received for subscriptions, advertising, etc., 1915		2,376.34
To stamps and stamped envelopes	$52.64	
Printing	1,530.59	
Halftones	150.87	
Miscellaneous supplies	38.40	
Refunds on subscriptions	4.00	
Returned checks	5.60	
Clerical work, Editor's office	50.00	
Clerical work, Manager's office	35.63	
Salary, Editor	100.00	
One-half salary of Manager	50.00	
	$2,017.73	
Balance December 23, 1915	755.02	
	$2,772.75	$2,772.75

Deposited in Malden National Bank $755.02

Respectfully submitted,

A. F. Burgess,
Secretary.

On motion the report was accepted and the financial part referred to the auditing committee.

Secretary A. F. Burgess: I would like to make a brief statement in regard to the Journal. During the past year there has been an increase in the subscription list of 44 so that we now have 764 subscribers. The number would be materially increased if the members would interest themselves in securing a few new subscribers. Although a large number of foreign subscriptions have been cancelled through

the year, enough new ones have been secured so that a net gain of three has resulted. I hope the members of the Association will endeavor during the coming year to increase our subscription list.

PRESIDENT GLENN W. HERRICK: I will now read the report of the executive committee but before doing so will ask Prof. F. M. Webster to occupy the chair.

REPORT OF THE EXECUTIVE COMMITTEE

The Association received an invitation from the Honorable William J. Bryan, Secretary of State, to participate in the Second Pan-American Scientific Congress which is now meeting in Washington, D. C. In response to this invitation, the President appointed Doctor C. L. Marlatt of Washington, as delegate, and Doctor W. J. Holland of Pittsburg, because of his wide acquaintance with the South American scientific men, as alternate delegate. Both of these men accepted and expressed their intention of attending the meeting.

The Special summer meeting of the Association was held at Berkeley, California, August 9 and 10, in accordance with the decision of the Association made at the last annual meeting at Philadelphia. This was a very profitable and interesting meeting but, unfortunately, was not attended by as many eastern entomologists as could have been wished. The first Vice-President presided in the absence of the President who was not able to be present.

The Executive Committee has been charged with the responsibility of selecting a design for a seal for the Association. The chairman has corresponded regarding the matter with the other members of the committee, and with several of the older members of the Association to obtain ideas and suggestions. Those who favor the profile of an insect for the seal argue for the Rocky Mountain locust and Colorado potato beetle. The majority of those with whom we have communicated do not favor the profile of an insect but are rather overwhelmingly in favor of the profile of Harris, the father of economic entomology. We quote briefly; the first "thinks the suggestion of Harris' profile is a most excellent one. Personally, I have got rather tired of these seals displaying an insect." Another says, "I do not think it wise to select any single species of insect for a seal for the Association of Economic Entomologists. I should by all means favor a relief of Harris' profile." To a third, "It seemed questionable whether an insect should be used"; while a fourth is not "keen for any insect in the seal" and prefers the profile of Harris. Another says, "As a central idea, I have thought over many things but nothing comes to me more appropriate than the portrait of the first official entomologist in America, the country in which economic entomology had its beginnings." As a final suggestion, the following from one of our oldest members is well worth serious consideration; "A plain seal with the name of the Association and the date of incorporation should be all that is necessary, and perhaps will be in better taste and much cheaper than one which carries what might be termed "*An appropriate design*."

The Executive Committee does not care to make a definite recommendation regarding the design but believes it would be wise for the Association to settle the question at this meeting.

GLENN W. HERRICK,
W. E. RUMSEY,
E. F. PHILLIPS,
A. F. BURGESS,
Executive Committee.

MR. F. M. WEBSTER: You have heard the report of the executive committee. What action do you wish to take? On motion the report was adopted as presented. A general discussion followed in regard to the adoption of an official seal and it was voted to defer final decision until the last session of the meeting.

PRESIDENT GLENN W. HERRICK: The next on the program is the report of the employment bureau which in the absence of Dr. Hinds will be read by the secretary.

ANNUAL REPORT OF ENTOMOLOGIST'S EMPLOYMENT BUREAU

December 27, 1915.

GENERAL STATEMENT

During the past year the Employment Bureau has received thirty-two new enrollments. These, with the names carried over from 1914, make about fifty men now on the roll. These names represent all grades of experience and equipment, from those just beginning in entomological work to men who have had extended opportunities and achieved international reputations.

During 1915 a general effort for economy was manifested throughout the United States, and would seem to have been responsible, in some measure at least, for both the large number of enrollments and the small number of changes or new positions which have come to our attention during the year. Six men appear to have been placed through information given by the Bureau, and two or three other positions are now in process of being filled. During the year some six hundred and fifty letters have been sent out in the work of the Bureau.

We would repeat suggestions made last year in regard to the need for candidates to keep us in closer touch with their changes of address and new lines of work. We would urge also that it will multiply the usefulness of the Bureau if employers will give us more general opportunity to supply them with the addresses of men who would seem to have the qualifications required for any entomological positions that they may have to fill.

One difficulty or limitation in the work of the Bureau may be found in the fact that all United States Department of Agriculture appointments are based upon Civil Service examinations. Thus the largest employer of entomological labor, The United States Bureau of Entomology, is practically placed outside of the field of work of the Employment Bureau. While many of our enrolled men have taken Civil Service examinations and may receive appointments in the Bureau of Entomology, the Employment Bureau cannot, under present arrangements, perform any service in bringing these parties together.

The financial statement for 1915 is appended hereto.

FINANCIAL STATEMENT OF THE BUREAU

	Dr.	
Cash on hand January 1, 1915	$27.01	
To 32 enrollment fees at $2	64.00	
Total receipts		$91.01

	Cr.	
March 20, 1915, to multigraphing letters (voucher 1)............	$ .60	
May 20, multigraphing letters (voucher 2)...................	.40	
July 10, by typewriter paper, W. E. Hinds cash (voucher 3).......	1.20	
August 6, postage (voucher 4)............................	10.00	
August 25, stenographic work N. C. Powell (voucher 5)..........	18.50	
December 3, multigraphing work (voucher 6)..................	.75	
December 22, stenographic work (voucher 7)..................	10.00	
December 22, W. E. Hinds cash, postage and stationery (voucher 8)	4.86	
Total..		46.31
Balance cash on hand December 22, 1915.....................		$44.70

W. E. Hinds,
In Charge.

On motion the report of the employment bureau was accepted and the financial part referred to the auditing committee. It was also voted that a general consideration of the work of the employment bureau be taken up at the final session.

President Glenn W. Herrick: We will now hear the report of the committee on nomenclature by Prof. Herbert Osborn.

TO THE ASSOCIATION ECONOMIC ENTOMOLOGISTS

At the last meeting of the Association, your committee on nomenclature presented without recommendation a request from Dr. H. J. Franklin that the names of the black-head cranberry worm, *Rhopobota vacciniana*, and the yellow-head cranberry worm, *Peronea minuta* be changed to the Flowed-bog fire worm and the dry-bog fire worm respectively. By action of the Society the matter was referred back to the committee with instructions to secure additional information and to determine the desires of those interested in the cranberry insects in different parts of the country. In accordance with these instructions, the committee has received during the year a request from Dr. Franklin and others interested in the matter requesting that instead of the former names and the names proposed last year, the name black-head fire worm be used for *Rhopobota vacciniana* and the yellow-head fire worm for *Peronea minuta*. As these names seem to satisfiy the persons most interested, including Dr. Franklin, members of the Bureau of Entomology and the President of the Cranberry Growers Association, the committee respectfully recommends that they be adopted and recommended for general use in place of the names hitherto adopted by the Society.

Herbert Osborn,
W. E. Britton,
E. P. Felt,
Committee.

After a brief discussion it was voted to accept the report of the committee and adopt the names as suggested in that report.

President Glenn W. Herrick: As the report of the committee on entomological investigations has not been received and as the chair-

man of the committee on bibliography of economic entomology has been delayed in reaching the meeting, the latter report will be considered at the final session of the meeting.

I will now appoint the committees:

The Committee on Auditing—T. J. Headlee and C. R. Crosby.

The Committee on Resolutions—Geo. A. Dean, W. C. O'Kane, S. J. Hunter.

The Committee on Nominations—E. P. Felt, R. L. Webster, H. A. Gossard.

Are there any matters to be considered under miscellaneous business?

SECRETARY A. F. BURGESS: Some difficulty is experienced each year in arranging the program for the meeting and a considerable number of members usually fail to send in their titles before the time limit for receiving titles expires. This has caused considerable disappointment among the members and I would, therefore, move that a committee of three be appointed to consider the matter of program so that the secretary may conform strictly to the wishes of the Association in preparing future programs.

MR. HERBERT OSBORN: In studying the program I notice that a paper is scheduled by Dr. Howard before this Association at the same time that one is to be presented by Professor Webster before the Entomological Society of America. It seems to me it might be possible to arrange the program for both societies so that all the members could hear these papers. This committee should confer with the committee of the Entomological Society of America and see if this can be brought about.

After a general discussion it was voted that the committee be appointed to take up both of these matters and report on the rearrangement of the program at the Tuesday morning session.

PRESIDENT GLENN W. HERRICK: I will appoint the following committee: Herbert Osborn, F. M. Webster and H. A. Morgan. It is also necessary to appoint a committee to consider the proposed amendments to the constitution and by-laws and I will ask the following men to serve on this committee: J. M. Aldrich, J. G. Sanders, E. F. Phillips.

At the opening session Tuesday morning the committee on program recommended that the officers of the association be authorized to arrange with the officers of the Entomological Society of America for a joint session Thursday morning so that the members of both societies could hear the papers by Dr. Howard and Professor Webster; also that papers received after the program closed be placed at the end of the program and that the other papers be advanced on the program as rapidly as time permits. It was voted to accept the report of the committee.

PRESIDENT GLENN W. HERRICK: Mr. Felt, as chairman of the nominating committee, has called my attention to the fact that the members who were elected last year to serve as councillors to the American Association for the Advancement of Science are not present at this meeting. The committee suggests that W. A. Riley and H. A. Morgan be designated to serve in this capacity. It was voted to accept the recommendations of the committee.

MR. F. M. WEBSTER: As most of you know, Professor Summers, one of the older members of our Association, is very sick. I would, therefore, move that the secretary be instructed to send a telegram to Professor Summers extending the sympathy of the Association. Adopted.

The final business session was held Thursday morning, December 30.

PRESIDENT GLENN W. HERRICK: We will now listen to the report of the committee on auditing.

REPORT OF THE AUDITING COMMITTEE

COLUMBUS, O., December 30, 1915.

To the American Association of Economic Entomologists:

This is to certify that the undersigned, your committee on audit, has examined the accounts of the Treasurer including those of the association proper and of the JOURNAL, and has found them to be satisfactory and correct.

This is to certify, further, that your Committee has examined the accounts of the Entomologist's Employment Bureau and has found them to be correct.

THOMAS J. HEADLEE,
C. R. CROSBY,
Auditors.

On motion the report was accepted.

PRESIDENT GLENN W. HERRICK: We will next listen to the report of the committee on resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Your Committee submits the following:

I. The Association desires to express to Professor Herbert Osborn and his associates, Professor H. A. Gossard and his associates, Mr. N. E. Shaw and his associates and all other entomologists of Ohio, and to the Ohio State University, its hearty gratitude for their cordial hospitality and for the admirable facilities provided by them for the association meetings.

II. WHEREAS, the Index of American Economic Entomology covers a decade of most productive work and is nearly indispensable to every economic entomologist, therefore be it, *Resolved*, that, in view of the great utility of this compilation, the Secretary of Agriculture, through the Bureau of Entomology, be most strongly urged to arrange for its speedy publication.

GEO. A. DEAN,
WALTER C. O'KANE,
S. J. HUNTER,
Committee.

It was voted that the report be accepted.

PRESIDENT GLENN W. HERRICK: The report of the committee on membership is next in order.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The committee on membership recommend:

(1) That the following named persons be elected to associate membership:

Walter Wellhouse, Lawrence, Kan.
Don B. Whelan, East Lansing, Mich.
Asa C. Maxson, Longmont, Colo.
Geo. H. Vansell, Lexington, Ky.
Frank M. O'Byrne, Gainesville, Fla.
James G. Needham, Ithaca, N. Y.
H. J. Speaker, Sandusky, Ohio.
Paul R. Myers, Hagerstown, Md.
Simon Marcovitch, University Farm, St. Paul, Minn.
Frank Mervyn Littler, Launceston, Tasmania.
James Calvin Goodwin, College Station, Texas.
Howard H. Jewett, Lexington, Ky.
E. O. Essig, Berkeley, Cal.
Morley Pettit, Guelph, Ont.
Frank H. Lathrop, Geneva, N. Y.
Max. Kislink, Jr., Washington, D. C.
Stanley Black Fracker, Madison, Wis.
C. L. Scott, Wellington, Kan.
Joseph Douglas Hood, Washington, D. C.
Jesse R. Christie, College Park, Md.
Ed. L. Ayers, Austin, Texas.
Edwin Cooper Van Dyke, Berkeley, Cal.
W. M. Gifford, Honolulu, Hawaii.
O. W. Rosewall, Baton Rouge, La.
E. A. Vaughn, Auburn, Ala.
Frederick Azel Fenton, West Lafayette, Ind.
Jerauld A. Manter, Storrs, Conn.
Olden Key Courtney, College Station, Texas.
J. Edward Taylor, Salt Lake City, Utah.
H. Gordon Crawford, Wilton Grove, Ontario, Canada.
Loren B. Smith, Blacksburg, Va.

(2) That the following named persons be transferred from associate to active membership:

G. M. Bentley, Knoxville, Tenn.
C. W. Collins, Melrose Highlands, Mass.
D. T. Fullaway, Honolulu, Hawaii.
W. H. Goodwin, Wooster, Ohio.
F. Z. Hartzell, Geneva, N. Y.
C. L. Metcalf, Columbus, Ohio.
E. R. Sasscer, Washington, D. C.

(3) That by his request Mr. P. B. Gregson, Reesland, Rosemount, Romford, Essex, England, be transferred from active to associate membership.

(4) That the following resignations be accepted:

H. G. Dyar, Washington, D. C.
I. J. Condit, Berkeley, Cal.
R. W. Hegner, Ann Arbor, Mich.
C. P. Smith, College Park, Md.
H. E. Weed, Beaverton, Ore.
P. S. Welch, Manhattan, Kan.

(5) That the Secretary be instructed to notify the four active and the six associate members who are in arrears for dues for two years that if such dues are not paid within three months their names will be dropped from the roll.

Respectfully submitted,

WILMON NEWELL,
WALTER C. O'KANE,
J. G. SANDERS,
Committee.

By vote of the Association the report was accepted and the recommendations adopted.

PRESIDENT GLENN W. HERRICK: We will now pass to the report of the committee on amendments to the constitution.

REPORT OF THE COMMITTEE ON CONSTITUTIONAL AMENDMENTS

The Committee on Constitutional Amendments beg leave to report that they have considered the proposed amendments as printed in the program, and recommend that they be adopted.

Respectfully submitted,

J. M. ALDRICH,
J. G. SANDERS,
E. F. PHILLIPS,
Committee.

PRESIDENT GLENN W. HERRICK: Is there any discussion of this report?

MR. W. C. O'KANE: I would like to ask for a statement in regard to the first amendment which is proposed.

SECRETARY A. F. BURGESS: Perhaps I can explain this matter better than anyone present as I attended the summer meeting at Berkeley, Cal. At that meeting the Pacific Slope Association of Economic Entomologists held several joint sessions with this Association and they asked that a joint committee be appointed to consider what could be done in bringing about an affiliation of that association with ours. A committee was appointed and the matter was considered and a report of it will be found in the October number of the JOURNAL. The sentiment at that meeting was very favorable toward becoming affiliated with this Association, although it was explained that this Association could not act definitely on the matter at that meeting. In order to bring about the affiliation it seemed necessary to slightly amend our constitution so that the Pacific Slope Association could become a branch of this Association. Our constitution at present provides for sections which are based on projects or activities such as nursery inspection, apiary inspection, etc. The term "branch" would refer to geographical divisions of the country and seemed to be more appropriate than to use the word "section" for such a division. I sincerely hope the amendment will be accepted as proposed by the committee. I think it is a step in the right direction as it will bring together all the economic entomologists in the country under one strong association. The men I conferred with on the coast were anxious to see the matter acted upon favorably and I think this is the logical thing for us to do.

By vote of the Association the amendments were accepted as recommended by the committee.

AMENDMENTS TO THE CONSTITUTION.

Section I, Article III, insert the words "branch or" before the word "section" in line two so that the first sentence of Section I will read as follows: "The officers shall consist of a president, one vice-president and an additional vice-president for each branch or section who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws."

Add a new section to Article II as follows: "Section IV. The publication of the JOURNAL OF ECONOMIC ENTOMOLOGY shall be entrusted to an editor, an associate editor and a business manager nominated by an advisory committee of six members, which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted editorial board."

On motion of Mr. E. P. Felt the executive committee was authorized to accept and take the necessary action on the application of the Pacific Slope Association of Economic Entomologists as a branch of this Association.

PRESIDENT GLENN W. HERRICK: The next business on the program is the nomination of JOURNAL officers by the advisory board. Only one member of this board is here and he has had no time to give attention to this matter. It has been suggested that the Association by general motion elect the officers as it is necessary that the matter be acted on at this time.

MR. C. GORDON HEWITT: I move that the present officers of the JOURNAL be elected for the ensuing year.

The motion was unanimously adopted.

PRESIDENT GLENN W. HERRICK: I now call for the report of the committee on index of economic entomology.

REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

It is a pleasure to state that, through the coöperation of Dr. L. O. Howard and the untiring efforts of Dr. Nathan Banks, this important work will be completed shortly. Dr. Banks, who has had immediate charge of the undertaking, states that about 24,000 references have been entered and fully 1,000, possibly 2,000 or more from the less important agricultural journals are yet to be assembled. He is of the opinion that the work can be completed possibly in one, and certainly in two months. The index will make, if printed as planned in ten point type, double column, a publication of approximately 250 pages. This is more than was estimated in December 1914 and just about the size of the bibliography as planned in 1913.

There is no question as to the great utility of this work and we feel that it marks a distinct advance in reference literature. Your committee recommends that the undertaking be pushed to an early completion and that in the event of its being impossible to find any other satisfactory publishing agency, that the American Association of Economic Entomologists issue the index in accordance with the plan outlined in the report which was submitted and favorably acted upon at the Atlanta meeting.

Furthermore, the committee would recommend, as a slight recognition of the work done by Dr. Banks upon this project, that his membership dues and subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY be remitted for a period of five years.

Respectfully submitted

E. P. FELT,
A. F. BURGESS,
W. C. O'KANE,
W. E. BRITTON,
W. E. HINDS,
Committee.

MR. S. J. HUNTER: I move the adoption of the report as read by the committee. Carried.

PRESIDENT GLENN W. HERRICK: It was voted at the opening session to consider the work of the employment bureau at this time.

After a general discussion it was voted that the executive committee request the director of the employment bureau to prepare a report covering the work of the bureau since its establishment for consideration at the next annual meeting of the Association.

PRESIDENT GLENN W. HERRICK: The final report of the committee on program should be given at this time but as it has not been received suggestions concerning future programs are in order.

A general discussion followed and the concensus of opinion seemed to be that the secretary should arrange with the secretary of the Entomological Society of America to avoid as much as possible the overlapping of the programs.

A motion to reduce the maximum length of time for the delivery of a paper from fifteen to ten minutes was discussed but the motion was lost.

PRESIDENT GLENN W. HERRICK: We will now hear the report of the committee on nominations.

REPORT OF THE COMMITTEE ON NOMINATIONS[1]

The committee recommends the election of the following:

For President, C. Gordon Hewitt, Ottawa, Can.

For First Vice-President, G. A. Dean, Manhattan, Kan.

For Second Vice-President (Pacific Coast Branch), E. D. Ball, Logan, Utah.

For Third Vice-President (Horticultural Inspection), W. J. Schoene, Blacksburg, Va.

For Fourth Vice-President (Apiary Inspection), T. J. Headlee, New Brunswick, N. J.

For Committee on Nomenclature, W. E. Britton, New Haven, Conn.

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[1]The Second Vice-President has been approved by the Board of Directors to complete the organization of the Pacific Coast Branch.

The Board of Directors also appointed Prof. V. L. Kellogg a member of the Advisory Committee of the JOURNAL OF ECONOMIC ENTOMOLOGY to fill the vacancy caused by the death of Prof. F. M. Webster (*Secretary*).

For Committee on Entomological Investigations, H. T. Fernald, Amherst, Mass.

For Committee on Membership, J. J. Davis, Lafayette, Ind.

For Councillors to the American Association for the Advancement of Science, C. P. Gillette, Ft. Collins, Col., G. W. Herrick, Ithaca, N. Y.

For Director of Entomologist's Employment Bureau, W. E. Hinds, Auburn, Ala.

For the Advisory Board of the JOURNAL OF ECONOMIC ENTOMOLOGY, C. P. Gillette, Fort Collins, Col., W. E. Hinds, Auburn, Ala.

Respectfully Submitted,

E. P. FELT,
R. L. WEBSTER,
H. A. GOSSARD,
Committee.

By vote of the Association the secretary was instructed to cast one ballot for the officers mentioned in the report. The ballot was cast and they were declared elected.

PRESIDENT GLENN W. HERRICK: Is there anything else under the head of miscellaneous business?

SECRETARY A. F. BURGESS: I wish to read a telegram which was sent by direction of the Association to Mr. H. E. Summers:

December 29, 1915.

To H. E. SUMMERS,
Albuquerque, New Mexico.

"American Association of Economic Entomologists sends hearty greetings and best wishes."

GLENN W. HERRICK, *President.*
A. F. BURGESS, *Secretary.*

PRESIDENT GLENN W. HERRICK: We should consider at this time the design to be used on the official seal of the Association.

On motion it was voted that the matter be referred to the executive committee who should select either a profile of Dr. Harris or a plain seal, with power to adopt and have the seal prepared for official use.

PRESIDENT GLENN W. HERRICK: The next on the program is fixing the time and place of the next meeting.

On motion it was voted that the next meeting be held at the same time and place as the meeting of the American Association for the Advancement of Science.

PRESIDENT GLENN W. HERRICK: I wish to take this opportunity to thank all for their coöperation in making this meeting a success and particularly the effective service of those who acted on committees. If there is no further business we will adjourn.

Adjournment 1.30 p. m.

PART II. PAPERS AND DISCUSSIONS

THE PRESIDENT'S ADDRESS

THE NEED OF A BROAD, LIBERAL TRAINING FOR AN ECONOMIC ENTOMOLOGIST

By GLENN W. HERRICK, *Ithaca, N. Y.*

"The worst weed in corn may be corn,"

"So a too exclusive study of entomology is the poorest kind of preparation for an entomologist."

We are fortunate individuals in many respects. We are fortunate in living in an era of almost incredible progress in our knowledge of the secrets of nature. The boldest imagination would hardly dare to predict regarding the advances and discoveries that may be made in the next ten years in the field of the natural sciences. No part of this field of knowledge has been entirely exempt from this general advance; and in no phase of the work has there been more amazing progress than in that of the applied science of entomology. It has advanced astonishingly in the number of persons engaged in the study of insects for the ultimate purpose of preventing their ravages; in developing and perfecting mixtures for repelling and killing them; in devising effective apparatus for applying insecticides; and in determining more exact methods of preventing the losses caused by these persistent pests.

We are also fortunate in being associated with a phase of scientific work that is in accord with the modern trend of ideas and with the demands of the age. That is, we are engaged in a practical, economic and applied phase of the science. We shall not have to shift our ground in this respect as some of the related sciences are being forced to do. For example, one of our most distinguished botanists has said, "It can scarcely be successfully denied that the most significant recent advances in American botany have been along economic lines. . . . It is scarcely to be supposed that economic botany is a passing fad and that pure botany, as we call it, will once again come into a place of dominance. The shifting emphasis in botany is but a part of a great movement as broad as humanity itself."

Others of the so-called pure sciences are feeling this pressure of the economic or applied influence and are slowly shifting their grounds. We, however, are already allied with a young and rapidly advancing science that, from its applied nature, is in accord with the tendency

of the present ideas and activities of humanity. We are, therefore, to be congratulated both on the splendid progress of our profession and on its harmonious relations to humanity. On the other hand, lest we become lulled into a sense of security regarding the state of our science, lest we become filled with a dangerous sense of complete satisfaction with our past and present achievements, and lest we magnify too much the desirability of a practical preparation for our work, I am going to take this opportunity of urging the need of a broad, thorough and rigid training for our future activities as economic entomologists.

It is well to realize that we are yet far from a satisfactory solution of many pressing entomological problems. A large part of the widespread interest shown in economic entomology at the present time is due not so much to the striking results already achieved as to the increasing demand for the accomplishment of greater things and the solution of new and more perplexing problems. Many of the simpler problems of our work have been fairly well solved. The more obvious and easy steps have been taken. We are now confronted with the more abstruse questions of insect control, the proper solution of which, calls for the highest sort of mental preparation, for the broadly trained type of mind—the mind that has been developed until it has become imaginative, until it is able to dream dreams. The speaker has not the time or space to defend the thesis that imagination is necessary even in an applied science. He will only ask if the men who invented the steam engine, the sewing machine, the telegraph, the telephone, or the monotype machine did not have minds replete with imagination. Yet these appliances are among the most practical in use today by the human race. There are big things in the field of economic entomology awaiting the minds that have become trained until they are able to see far ahead of mere facts—until they have attained the intuition of seers and the imagination of poets.

LeBaron in 1870 exercised a trained judgment and responded to the impulses of an imaginative mind when he recommended that an apple tree should be syringed with Paris green for canker worms; and what a remarkable suggestion it was and what a revolution it started in the control of insect pests in this country! Harris, a recluse among books, for he was a librarian most of his life, wrote a classic in American economic entomology. Nothing but his lively imagination and broad interests developed by a thorough training of the mind enabled him to accomplish so much under so many difficulties.

What a vision of the wonderful means of the multiplication of certain parasites and perhaps of their increased efficiency in the control of noxious insects was unfolded to us by Marchal's discovery of poly-

embryony! This brilliant piece of work was really the result of a most thorough, broad and extensive preparation on the part of Marchal, as an embryologist. The significant feature of the whole matter to me, is the fact that the training was doubtless acquired without the material thought in mind that it might produce results of a profound practical bearing on certain fundamental biological problems.

Sir Ronald Ross's successful search for the species of mosquito acting as a reservoir for the malarial germ sounds almost like a fairy story and as interesting as an Arabian Night's tale. Only a man of vivid imagination and of profound faith in himself and his judgment engendered by a broad and vigorous training could ever have persisted in the search and brought it to so brilliant a conclusion.

Not one of these discoveries or pieces of work was the result of accident or of haphazard experimenting. Each was the deliberate outcome of a broadly trained and imaginative mind. Each was the fruition of long and arduous study in wide fields of knowledge and each has marked an epoch in the history of economic entomology and its relation to the human race. What one of us younger men feels that he has prepared himself broadly enough, intensively enough, culturally enough, and imaginatively enough to contribute as large a share to the advancement of the science?

I have been greatly interested in reading again the papers on the teaching of entomology presented to this Association in 1911 by four of the pioneer teachers of this subject in the United States. Again, I have been profoundly impressed with the fact that all of them, each unknown to the other, greatly stressed the need of a broad, foundational training for successful work in economic entomology. It is well worth while to quote briefly from these papers. The first speaker says, "Thus early I gained a hint of the scope of entomology and was led to realize that the practical application of the science should be based upon a broad and accurate foundation of scientific knowledge." The second speaker says, "For the intending graduate student, therefore, I would urge a broad undergraduate course with plenty of chemistry, physics and botany but with sufficient attention paid to the cultural subjects and those connected with our duties, as citizens, to give breadth in every way, languages as tools aside from their cultural value should not be omitted." The third speaker emphasizes the desirability of a broad training in these words, "There is, therefore, the necessity that we should have trained investigators for the acquisition of further knowledge concerning insects, the discovery of which is one of the most important duties of modern entomology. For the purpose of this kind of instruction, it is absolutely necessary that there be thorough training in related sciences as well as in the general foun-

dation in other branches of knowledge." The last speaker requires his students to take work in zoölogy, botany, Latin, German, and French, not merely for their utility but also because of their cultural and broadening value. Thus we have in the foregoing brief quotations a forceful summary of the opinions of our older and more experienced teachers on this fundamental question. But let us consider this question in the light of recent developments.

Within the last two decades, applied entomology has shown such a marked and rapid trend in a certain direction that it demands our attention and careful consideration in connection with the theme of this discussion. I refer to its conspicuous tendency to come closer and closer to the vital activities of human beings. As a result of this trend, the economic entomologist suddenly finds himself drifting more and more into intimate relations with humanity. One has but to recall the fly and mosquito campaigns in many localities of our country; the work of Gorgas and his assistants in making the Panama Canal a possibility; the work of the physicians, Reed, and his associates on the field of Quemados and the entomological significance of that work; and the campaign against fleas in San Francisco to check the bubonic plague, to realize the force of the foregoing statement. Moreover, the work of the Horticultural Commission of California, practically an entomological quarantine board, in the seaports and counties of that state; the functions, rights and responsibilities of the Federal Horticultural Board; and the several state entomological quarantine regulations, all show how intimately the economic entomologist is dealing with the very life and economic forces of the people.

I have been profoundly impressed, while watching the westward march of the cotton boll-weevil, with the effect a single insect may exert on the economic life of a people. This insect has changed the agricultural thinking of the South and will ultimately bring about a marked change in the agricultural practice of the people in the infested territory. Affecting as it does the most important crop grown in the United States by virtue of its peculiar economic position, because cotton serves virtually as a means of exchange, and because it, beyond any other exported product in the United States, serves to settle our debts abroad, the weevil could not fail to affect vitally the economic welfare of the people; and any entomologist dealing with it becomes, by virtue of his profession, intimately associated with the welfare and very existence of his constituents.

I have also been keenly sensible of the influence of the malarial mosquitoes on the energy, efficiency, and accomplishment of a people. And the men now engaged in studying this problem will find themselves ingratiated into the lives of the people about them and will add to the prestige of our profession among the people of this country.

The economic entomologist is inevitably drifting more or less into the rôle of a leader in his community or state. The influence of his presence among the progressive farmers of his territory is bound to make itself felt. Leadership demands a true understanding of real, effective service to humanity and he who serves his fellowmen best and most lastingly, must be a man of wide, clear vision, liberal ideas, and large sympathies.

We are gratified with this growing position of the economic entomologist in the affairs of the people; but we must realize that it brings added and grave responsibilities which must be lived up to and met in exactly the same catholic spirit in which they come to us. To meet these duties in a large, sane, and efficient way, a man should possess sound judgment and wide knowledge of men and their affairs. We have been delighted and inspired by the fact that one of our older members has been recently honored as the leading citizen of his state. Not alone because of his purely entomological work but because his work was broad enough and sane enough to fit into the lives and activities of the people. It seems to me that the economic entomologist of the future must acquire a wide and thorough knowledge of the history and development of his country, of the characteristics, ideals, and aims of his people and of the economic forces governing their welfare.

Again, there are other phases of the more recent developments of economic entomology that emphasize the need of a thorough and liberal preparation. For example, the work in so-called medical entomology is calling for the highest type of broadly trained men. The discoveries of the direct relations of insects to man have opened up a tremendously vital field of work for the economic entomologist. The problems in this field that will present themselves in the future are sure to be complex and intricate and to be bound up closely with interrelated problems that will demand broad knowledge, trained judgment, profound insight, and the ability for the closest scrutiny and discrimination. No one who has not been trained to close, extended application, and who has not had the imagination developed, need expect to solve successfully the problems in this field.

There is another development or tendency arising in the botanical-zoölogical field that in order to be met and stemmed successfully will demand thoroughly trained men and a high type of work. I refer to the tendency to submerge economic entomology in the field of phytopathology. Doctor Howard has already pointed out the absurdity of this movement and the need of resisting it. One of the most successful means of preventing this tendency from being realized is for the economic entomologist to perform his work in such a broad, fundamental manner that it will be differentiated as a clear and dis-

tinct field from that of plant diseases. Fundamental, basic work of this kind demands a liberal and rigorous mental training.

Again, we hear a great deal these days about research but I am afraid that we do not grasp all that is being said concerning it. In fact, I sometimes wonder if the speakers themselves really understand all that they are saying on the subject. Of one thing, I am convinced. There is little use to talk of real research until genuine scholarship has been attained. The world is demanding research at a time, it seems to me, when we have somewhat fallen away from the rigorous methods of mental discipline of half a century or more ago. If we expect to discover basic facts and if we expect to justify the expenditure of the funds now being thrust upon us for research, we have got to reinstate a love for learning and a sincere desire for scholarship. We have got to foster and create scholars with an unquenchable thirst for the pursuit of the unknown and an ability to find it.

Not long ago, I had the opportunity of visiting certain intensely busy fields of economic entomological work in the southern part of the United States. During this trip, I saw two phases of work that greatly interested me and that left an impression on my mind that grows with the lapse of time. The two series of experiments dealt with the tropisms of two notorious insect pests—in one case with the chemotropism of a small beetle, in the other case, with the phototropism of a moth. I do not know that any satisfactory results in either case have yet been obtained. I do know, however, that these experiments are being made in a fundamental way and I feel that they are fraught with undreamed of possibilities in the way of insect control. It is neither appropriate nor desirable in this paper to discuss the tropisms of insects. What I desire to say is that here is a whole field, comparatively new, for the economic entomologists who are prepared to develop it. European entomologists are already entering the field. The work will demand thorough training in closely related sciences, intimate knowledge of foreign workers and their languages, a sane, well-balanced judgment that can correlate and interpret results, and a mind of imagination and vision that can see far ahead of mere facts. I look forward with great enthusiasm to the researches that are bound to be made in these fields when we develop men properly trained for the work.

This leads me to say a word regarding the desirability of every economic entomologist to have a knowledge of the history of his science. For a proper background of the science of applied entomology, one should have a fairly full knowledge of the history of the subject. Economic entomology, as a distinct field of endeavor, is comparatively young and a fairly complete knowledge of its rise and

progress can be rather easily obtained. The course of its development has been an interesting one and in many respects an inspiring one. The older workers, especially, have been men with whose lives we may very profitably become acquainted. I would earnestly urge every young man intending to follow applied entomology as a profession to become intimately acquainted with the lives of such men as Harris, Fitch, LeBaron, Walsh, Riley, Lintner, Fletcher and Saunders. I am convinced that a knowledge of the development of one's favorite science will act as an incentive and inspiration to fresh and extended endeavor. It will also aid in developing a worthy pride in adding something to what has already been done and will give a clearer view of what remains to be accomplished.

Lest I be misunderstood and lest some may fear that the speaker is overemphasizing the theoretical to the neglect of the practical side of an entomologist's training, allow me to say that elsewhere I have set down in detail what, it seems to me, would constitute an ideal course of study as preparation for applied entomological work. In that discussion I have admitted and emphasized the desirability of a certain amount of practical field work and have also noted its kind, its extent, and the place it might well occupy in such a course of preparation. The length of that discussion and the extent of what I desired to say in a more abstract way has precluded the possibility of including it here. I would like to say, however, in this connection, that there is a tendency among young men, especially undergraduates, to study only those things that they think are going to be of actual *use* to them in their future work. So many young men say to me that they do not want to take this or that course because it will be of no use to them in their profession as an economic entomologist.

It is probably true that the mere knowledge of the processes involved in the solution of an algebraic equation in quadratics, or the mere knowledge of the laws governing falling bodies or the Latin subjunctive may never be of actual practical *use* in checking the ravages of an insect pest. We must not expect to use everything we learn, neither ought we to learn only *those things we expect to be* directly useful. We do not study certain subjects with the expectation of using the formulas and equations on the field of battle with the codling moth. It is certainly true that we shall forget most of the facts we learn in college concerning mathematics, physics, Latin, chemistry, and kindred subjects; but not one of us will ever lose the broadness of view and culture of mind gained in acquiring this knowledge and not one of us will ever lose the benefit of mind training received from mastering these subjects. The significant fact, the fact that counts, is that the

mind has been trained and developed by close, accurate, rigorous thinking in several fields of knowledge.

But I hear some say that these are old, trite arguments. I admit it and agree that they are out of fashion; but I believe that these truths need to be resuscitated, revivified, and rehabilitated in the minds of the younger generation. I almost wish it were possible for a young man to go to college without having the thought foremost in his mind that he must fit himself to earn a living.

The modern cult of efficiency is misleading many young men into thinking that they must study only those things that make toward practical success in their chosen profession. We see Europe bathed in the blood of a mighty war because nations have as their highest ideals, apparently, the efficiency of their peoples in trade, in manufactures, in spreading over the earth and holding more land, in short, in performing greater material feats. Bailey has touched upon this question in a fine way when he speaks of the use of the land. He says, "It is urged that lands can be most economically administered in very large units and under corporate management; but the economic results are not the most important results to be secured, although at present they are the most stressed. The ultimate good in the use of the land is the development of the people. It may be better that more persons have contact with it than that it shall be executively more effectively administered." In other words, efficiency of administration, the securing of economic results may not be the most important objects in life. The development of men should be the highest aim of a system of education or of a government.

I plead for a broad, liberal training because I firmly believe that a course of study which demands logical, orderly rigorous thinking, consistently carried out over a period of several years during the growing and formative period of a young mind will contribute more toward making a faithful, honest, accurate observer and interpreter than any other form of intellectual training yet devised. I believe that a mental training of this character is one of the surest means of freeing the mind from prejudice, misconception and dogmatism.

I plead for a liberal intellectual training because it will widen one's perspective of life. The man who, especially during his younger, undergraduate days, is engrossed in one thing, who thinks of but one realm of nature, who deals with but one science, and who studies only one phase of the animate world is apt to become narrow and to lose understanding and appreciation of other lines of endeavor. More than that, he is liable to lose touch with the vital problems of life and humanity and fail to judge his problems in a large and adaptable manner. His very nearness to his work and his limited field of vision precludes the accomplishment of really vital things.

It is the lack of severe mental training; it is barely tasting the Pierian Spring, that breeds shallow thinking and superficial results. A scholar in his calmer moments, at least, as Milliken says, ought to "be a man who exemplifies in his whole life the very essence of temperance, a man who is always rational and consecutive in his thinking, just and truthful in his speech, dispassionate and fair in his analysis." The future work in applied entomology will demand, more than ever, scholarly men and these are to be obtained only through a course of broad training and rigorous thinking.

Finally, I would urge upon every teacher of entomology and upon every one interested in the success of our favorite science, the importance of emphasizing to young men, who contemplate choosing applied entomology as a field of labor, the desirability, nay, the necessity of a thorough and extensive preparation. Economic entomology will certainly play an increasingly important rôle during the coming years in the development of rural life. As our knowledge of the activities and habits of insects increases we realize more and more keenly the far-reaching effect these tiny but multitudinous animals may exert upon the basic welfare of all mankind. I am, therefore, profoundly impressed with the possibilities and the greatness of applied entomology as a profession and am greatly concerned with the need of young men being properly fitted for the work. Upon the young men now entering the profession will rest the responsibility of maintaining the fine reputation of the older workers, of adequately meeting the present problems, and of securely laying the foundations for the larger field of the future.

Reading of Papers

President Glenn W. Herrick: The first paper on the program will be given by Mr. J. W. McColloch.

A PRELIMINARY REPORT ON THE LIFE ECONOMY OF SOLENOPSIS MOLESTA SAY[1]

By J. W. McColloch and Wm. P. Hayes, *Assistant Entomologists, Kansas State Agricultural Experiment Station*

Introduction

In the spring of 1911, the Department of Entomology of the Kansas State Agricultural Experiment Station received several reports from southern Kansas of kafir seed being destroyed, [illegible]

[1] This paper embodies the results of some of [illegible] authors in the prosecution of project No. 9[illegible] Insects of Southern Kansas—of the Kansas St[illegible]

planted, by a small ant. Early in June, 1911, the senior author visited several fields where injury was reported and collected a large number of the ants, specimens of which were sent to Dr. W. M. Wheeler[1] who determined them as *Solenopsis molesta* Say. In investigating this injury it was found that several hundred acres of kafir had been destroyed and that many fields had been replanted three and four times. In 1912 and 1913 the reports of injury increased and it became evident that this pest was worthy of some investigational work. Accordingly, in 1914, a field experiment station was established at Winfield, Kansas, and the junior author placed in charge. This station has now been in operation two years and during that time considerable progress has been made toward a knowledge of this insect's life economy.

Classification and Synonomy

Solenopsis molesta belongs to the family Formicidæ, sub-family Myrmicinæ. It was originally described by Thomas Say in 1835 as *Myrmica molesta*. Dr. W. M. Wheeler has kindly furnished the following synonomy of this species:

Myrmica molesta Say, Boston Journ. Nat. Hist., 1, 1836, p. 293.
Myrmica exigua Buckley, Proc. Ent. Soc. Phila., 1866, p. 342.
Solenopsis debilis Mayr, Verhand. Zoöl. Bot. Ges. Wien. 36, 1886, p. 461.
Solenopsis molesta Emery, Zoöl. Jahrb. Abth. f. Syst., 8, 1894, p. 277.

There has been considerable confusion existing between *Solenopsis molesta* and the tiny house ant, *Monomorium pharaonis* Linn. Several writers considered Say's *Myrmica molesta* as a synonym of *Monomorium* and Mayr believed this to be the case when he described *Solenopsis debilis*. According to Doctor Wheeler, "Emery was the first to insist that this was merely a synonym of Say's *molesta*."

There are a number of references in the American literature to *Solenopsis fugax*, which is a European species. Doctor Wheeler in a recent letter says, "*Solenopsis fugax* is a European species and does not occur in this country. It is extremely close to *Solenopsis molesta*, however. Undoubtedly all references to *fugax* in American literature refer to *molesta*." For this reason the American references to *fugax* have been considered in this paper.

Distribution

Solenopsis molesta has a wide geographical distribution, being found over most of the eastern half of the United States.

[1] The writers desire to express their appreciation to Doctor Wheeler for determining the ants mentioned in this paper and for supplying the synonomy of *Solenopsis molesta*.

Say (1)[1] describes the species from specimens collected around Philadelphia. Fitch (2) records it in damaging numbers in New York as early as 1850. Mayr (7) described *Solenopsis debilis* from specimens taken in the District of Columbia, New Jersey, Virginia, Texas, and New York. Forbes (5, 13) reports it several times from Illinois. Wheeler (15) records it from the eastern and northern states, Texas, and as far south as Cuernavaca, Mexico. He also mentions finding a large nest on Naushon Island, Mass. Pierce (21), *et al*, found it in Oklahoma. Tanquary (23) records taking sex forms in flight at Boston, Mass. Gaige (25) found a single worker on a rock outcrop on Charity Island, Lake Huron.

This species appears to be well distributed over the eastern half of Kansas, specimens having been taken in twenty-two counties in the eastern part of the state.

History and Economic Importance

While there are many references to *Solenopsis molesta* preying on other insects and acting as a scavenger, it is primarily an injurious insect.

In describing this species, Say (1) states that this is the "little yellow ant" commonly found in houses and that it sometimes eats vegetable food and garden seeds.

According to Fitch (2), it is one of the worst ants infesting houses and fields in New York. It is very fond of saccharine substances and is commonly found feeding on sweetened foods, in the house. It is also found frequently in pastures and plowed fields and in 1850 it threatened the corn crop by gnawing the tender leaves.

Forbes (5, 6), in 1884, records *Solenopsis fugax* present in sorghum and broom corn fields, injuring the fruit of strawberries, and gnawing out seed corn. In 1894 (13), he reports *Solenopsis debilis* feeding on seed corn in the ground and kernels in the ear. He also observed this species attending the corn root aphis.

Webster (10, 11) in several papers describes this species as injuring strawberries, blackberries, seed corn, cured hams and ripe apples.

There are a number of references to this ant as a predaceous enemy of injurious insects. Brooks found *Solenopsis debilis* attacking the grape curculio (*Craponius inæqualis*) (16) and the walnut curculio (*Conotrachelus juglandis*) (18). Headlee and McColloch (22) often observed *Solenopsis molesta* carrying chinch bug eggs. Brooks and Blakeslee (26) found this species attacking codling moth larvæ.

In Kansas, the chief injury consists of destroying the seeds of kafir, cane, milo, and feterita shortly after they are planted. In a few cases

[1] Reference is made by number to "Literature Cited."

they have also been found injuring seed corn. Within a day or two after the seed is planted the ants attack it, hollowing out the kernel and generally preventing germination (Pl. 2, figs. 6 and 9). During the past four years thousands of acres of sorghum crops have had to be replanted from one to six times because of the ravages of this ant and in a number of cases it has been impossible to obtain a stand. With seed at $3.00 a bushel, as it was in 1914, this means a considerable money loss as well as time and labor spent in replanting.

Methods of Study

Considerable difficulty was encountered in finding a satisfactory method of rearing this ant under artificial conditions that would permit of daily examination. Because of the minute size of the workers, such cages as the Lubbock, Janet, and Fielde proved unsatisfactory. Finally, a modified type of the Janet cage was constructed, which, although not entirely satisfactory, proved useful. This cage (Pl. 2, fig. 8) is made by moulding a block of plaster of Paris in an ordinary dinner plate or saucer, having the upper surface level with the top of the dish. On one side a small cavity is cut away for a water chamber, which can vary in size according to the size of the cage. Opposite this an oblong chamber about one-eighth inch deep, two to three inches wide, and four to five inches long, is hollowed out and the half of it farthest from the water reservoir is painted black and covered over with a small square of glass. This gives a covered and an uncovered chamber. The former is covered with a small square of black cloth, making a very satisfactory dark chamber which can easily be uncovered to permit examination. The uncovered area is used for a food chamber, which readily permits of the removal of old or decayed food. To prevent escape of the ants the food chamber is completely surrounded by a barrier of vaseline, which must extend up and over the adjacent edge of the glass covering the dark chamber. An extra safeguard is had in placing a thin layer of vaseline around the dark chamber before the glass top is put on. This not only fills up any small crevices through which the ants could escape, but also prevents the glass cover from slipping out of place. By making the dark room near the edge of the dish, forms in the nest can easily be examined on the stage of a binocular.

This cage is not altogether satisfactory as the ants will sometimes burrow through the plaster of Paris into the bottom of the dish. Before ants become accustomed to the vaseline many are caught in it, especially the winged forms, but after a time they learn to avoid it.

Larger ants like *Cremastogaster lineolata* Say and *Iridomyrmex pruinosus* Roger were kept quite successfully in these cages.

When the cage difficulty was eliminated, other serious problems presented themselves. As yet no single individual has been followed through all stages of its life cycle. The immature forms cannot be kept under observation when piled upon each other in large colonies. When small colonies are started, the cannibalistic instinct of the ants becomes more noticeable and before a series of eggs will hatch, or a group of larvæ become full grown, they may be eaten by their supposed caretakers.

Life-History

Egg.—The eggs (Pl. 2, fig. 1) are pearly white with a bright luster which changes, just before hatching, to a clear, semi translucent color. They are elliptical in shape and about .25 mm. long. The eggs are covered with a viscid substance which enables them to adhere in packets for purposes of transportation by workers or to the surfaces where deposited.

Eggs are laid by the fertilized queens and cared for by the workers. Queens, when unattended by workers, will care for and carry packets of eggs from place to place in the nests. Unless eggs are attended by either workers or a queen, they will not hatch.

Fertilized queens collected in the field and placed in artificial nests cease egg laying almost entirely, and the few that are occasionally laid are soon greedily eaten by the workers. This condition, coupled with the fact that large numbers of eggs in a nest are hard to keep under observation, makes it difficult to determine the length of the incubation period. The methods used by Newell and Barber (24) on the Argentine ant were employed to work out the length of the egg stage. A fertile queen was placed in a nest with a small number of workers and assuming the time from the laying of the first egg to the time of the first one hatching to be the time required for incubation. This period was found to vary from 16 to 28 days, depending on temperature and moisture conditions. The daily egg-laying record of eight queens was taken for a period of 16 days by removing from the nest eggs laid during each day. The average number of eggs laid was 103.3. The greatest number from one individual was 387 and the smallest was 27. One queen deposited 105 eggs in a single day. Table I shows how the egg record of a queen will decrease after being put in an artificial nest. This queen was taken in a large colony May 10.

TABLE 1. DAILY EGG RECORD OF A QUEEN

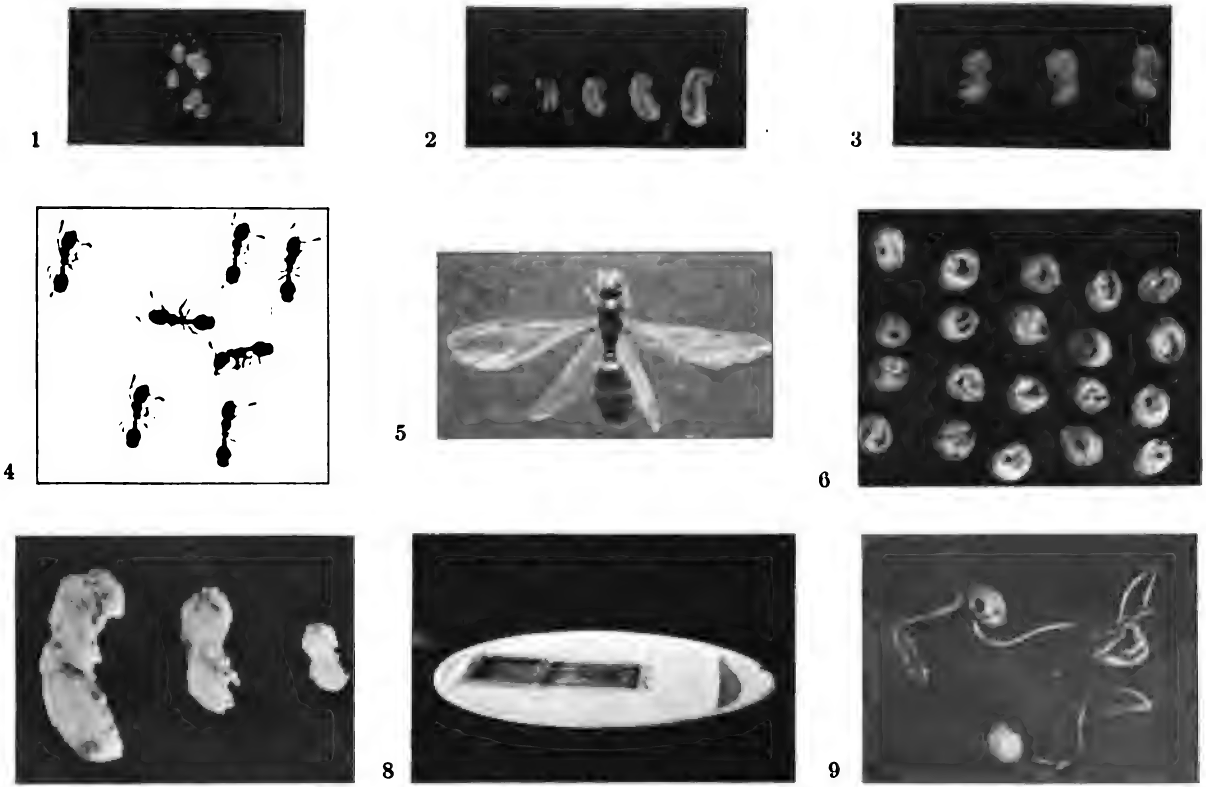
Date	No. Eggs Laid	Date	No. Eggs Laid
May 11	52	May 27	14
May 12	94	May 28	5
May 13	105	May 29	0
May 14	36	May 30	1
May 15	3	May 31	0
May 16	0	June 1	0
May 17	0	June 2	0
May 18	9	June 3	2
May 19	10	June 4	20
May 20	13	June 5	5
May 21	0	June 6	0
May 22 } May 23 }	16	June 7	1
		June 8	4
May 24	0	June 9	1
May 25	13	June 10	9
May 26	36	June 11	0

LARVA.—The larvæ (Pl. 2, fig. 2) of this species resemble superficially the larvæ of any other of the Myrmicine ants except, perhaps, in size. They are white in color and covered with double-hooked hairs which enable them to cohere in packets to be carried by workers. The posterior end is large and tapers toward the anterior end, which is considerably curved. This curvature becomes less pronounced as the larva grows older but is never entirely obliterated. Larvæ were frequently observed, while lying on their back, to straighten out their curved body by lifting their head and dropping it back onto the body. These movements are repeated at short intervals and the mandibles open at each up-movement and close on the down-movement. These moving larvæ were generally fed by workers at once, or soon after making these apparent supplications.

Larvæ are fed regurgitated food by the workers. Workers, in artificial nests, were often seen to place small bits of crushed kafir seed and torn parts of their own larvæ and pupæ on the body of the larvæ near the mouthparts where the larvæ were seen to bite them.

As the larva becomes full grown a large undigested meconium is voided from the alimentary tract. Workers were seen at times aiding the larva to get rid of this mass by tugging at it while it was being cast off. This change marks the end of larval development and the beginning of the semi-pupal stage.

The length of the larval stage is highly variable, depending on weather conditions. During midsummer larvæ were reared to the semi-pupal stage in 21 days, while others will live through the winter. A single larva was under observation from October 10 to May 12 when



1 2 3 4 5 6 7 8 9

1. Eggs; 2. Worker larvæ at different stages of growth; 3. Worker pupæ; 4. Workers; 5. Winged queen (♀); 6. Kafir seeds hollowed out by workers; 7. Comparative sizes of pupæ; queen (left), male (middle), worker (right), all enlarged; 8. Rearing cage used (dark chamber is uncovered), reduced; 9. Germinating kafir seeds hollowed out by workers, enlarged.

it transformed to the semi-pupal stage. The semi-pupal stage was found in midsummer to range from 2 to 11 days.

Large larvæ have often been encountered, in nests of this species, which were, undoubtedly, either larvæ of males or queens. None were ever reared successfully in artificial nests. Except for their much greater size, they seem to resemble the worker larvæ, and upon reaching their final stages of growth undergo similar changes.

PUPA.—The comparative sizes of the worker, queen, and male pupæ are shown in Plate 2, figure 7. The worker is the smallest, the male intermediate, and the queen the largest. The three forms are white during the early stages of pupal development, but as development proceeds they gradually assume the color of the adult form. The queen and worker pupæ become a pale yellow, almost as dark as the adult. The male changes to a dark brown before transformation.

The length of the worker pupal stage was found to be from 13 to 27 days. The same period for males and queens has not been determined. Worker pupæ, when ready to transform, are assisted in shedding their pupal skin by attendant workers. This skin is torn off in the form of a thread over the long axis of the body as one would unwind a skein of yarn. Pupæ are not enclosed in cocoons.

ADULT.—This species has but three kinds of adults, workers, males, and queens. There are no major and minor workers or soldiers. Workers, after emerging from the pupal stage, are very pale yellow in color and helpless. They are cared for by attendant ants which carry them about. In from two to three days these callows become thoroughly pigmented and are able to care for themselves. The worker (Pl. 2, fig. 4) is one of our smallest ants, being from 1.5 to 1.8 mm. long and is pale yellow in color. Vestigal eyes are present. The antennæ are ten-jointed. Spines are absent on the metathorax. The pedicle is two-jointed and the abdomen is armed with a sting. Say (1) in his original description says, "Their sting is like the puncture of a very fine needle." In two years' handling, the writers have never been stung by this ant. Workers constitute the greater part of the colonies.

The queen (Pl. 2, fig. 5) is of the same general yellow color as the workers with a darker (almost brownish) color on the head, prothorax, and between the dorsal abdominal segments. The prothorax is unarmed. Before fertilization, the queen has two pairs of hyaline wings which are lost after mating occurs. Antennæ are eleven-jointed.

Males are intermediate in size between the queens and workers. Their length varies from 3.5 to 3.6 mm. The legs and antennæ are

yellow, while the body color is a shining brown. The wings are hyaline. The antennæ have no club, as in the case of workers and queens, and the scape is also much shorter. The first funicular joint is enlarged to form the Johnstonian organ.

Habits

Locally, this species is known as the "kafir ant." Farmers whose crops have suffered from this pest know well the character of injury done, but seldom are acquainted with the depredator. This is, in part, due to their minute size and the hypogæic habits, although they are sometimes found on the surface of the soil.

The workers damage planted kafir seed in the same manner that has been reported by Forbes (13) for corn, who describes that injury as follows: "A kernel may be found wholly or partly hollowed out, the mealy interior being not devoured, but scattered about the earth, while the cuticle or outer shell of the seed remains but little disturbed." He is also of the opinion that the ants eat out the corn seed for the purpose of getting the oil. These attacks may occur before or after germination takes place, and in the case of kafir and other sorghums which they are known to damage, the seed apparently must be softened by moisture before they are attacked. Seeds that are injured after germination produce weak plants that soon perish. In southern Kansas, cane, milo, feterita, and maize also suffer to a more or less degree from the ravages of this pest. Workers have also been found feeding on windfall apples and plums, dead grasshoppers, larvæ, pupæ and adults of the maize bill-bug (*Sphenophorus maidis* Chittn.), larvæ of the corn-stalk borer (*Papaipema nitela* Gn.), larvæ of the Hessian fly (*Mayetiola destructor* Say), grasshopper eggs, pupæ of the corn ear-worm (*Chloridea obsoleta* Fabr.), and in 1905 they killed many larvæ of the white-marked Tussock moth (*Notolophus leucostigma* Smith & Abbot) in rearing cages at the Kansas Station.

The Colony

Nests are found in many different locations. Isolated nests are difficult to locate because of the small openings which are frequently some distance from the true nest. The colonies are numerous, but by far the easiest ones to locate are under rocks in pasture land. Nests have also been found in kafir, wheat, rye, oats, and alfalfa fields and are reported being in houses, but there are no records of this nature in Kansas.

Although isolated nests are frequently found in the open, or under rocks, this species seems to prefer building compound nests with other ants which they rob of their eggs, larvæ, and pupæ. It is not impossible, as is supposed in the case of *Solenopsis fugax* Lat., that these isolated nests of *molesta* may be connected with nests of other ants in the neighborhood by long underground galleries. It is by this hypogæic mode of travel that workers find and devastate fields of sorghum.

Isolated and compound nests are composed of small chambers whose walls are hardened and packed. They are connected by small galleries which, in compound nests, ramify through the workings of the colony of larger ants. The minuteness of these galleries prevents the larger ants from molesting the small invaders who forage with comparative safety.

Wheeler (15) reports *Solenopsis molesta* living in lestobiotic relationship with the following ants: *Pachycondyla harpax* Fabr., *Odontomachus clarus* Roger, *Camponotus fumidus* var. *festinatus* Buckley, *Camponotus maculatus* subsp. *sansabeanus*, *Formica sanguinea* subsp. *rubicunda* var. *subintegra* Emery, and different species of *Formica*, *Lasius*, *Stenamma*, and *Myrmica*. Forbes (17) records *Solenopsis molesta* living in harmony with *Lasius niger americanus* Emery.

In our work we have taken *molesta* in colonies of *Iridomyrmex pruinosus* Roger var. *analis* Andre, *Cremastogaster lineolata* var. *punctulata* Emery, *Ponera inexorata* Wheeler, *Pheidole* sp., and *Leucotermes lucifugus* Rossi.

In artificial nests *Solenopsis molesta* and *Cremastogaster lineolata* are decided enemies. The larger ants will bite and sting the smaller ants until they are exterminated but not, however, without a severe struggle in which the smaller ants bravely bite the legs and antennæ of the attacking giant. A compound colony of *Iridomyrmex pruinosus* and *molesta* was kept in an artificial nest without either being disturbed by the other. Each took up quarters in opposite sides of the nest.

In natural formicaries, winged males and queens appear in July. No data have been obtained on the mating flight. In artificial nests, queens were never fertilized. Tanquary (23) reports a mating flight in Boston as occurring September 5 at 5.00 p. m., and September 8. In artificial nests, queens unattended by workers will rear and care for the young. From this fact we can assume that, after fertilization, queens are able to establish new colonies without the aid of workers. In populous nests as many as nine fertile queens may be found. Table II gives the composition of a number of nests that have been examined.

TABLE II. COMPOSITION OF NEST

Date Collected	No. Workers	No. Pupæ	No. Semi-pupæ	No. Larvæ	No. Eggs	No. Queens (Winged)	No. Males (Winged)	No. of Larvæ and Pupæ of Sex Forms	No. Fertile Queens	No. Inquilines
April 16	149			31						20 mealy bugs
April 16	481			28						7 mealy bugs
April 19	1349			1902						
May 1	64		6	216						
May 10	535	324	456	662	1182				1	
May 29	*	*	*	*	*				9	
July 20	216	34		74	12	1				
July 28	336	247		78		4	2	73	1	1 mealy bug
Aug. 10	348	10		1						
Sept. 2	1436	2012	355	64	28					
Sept. 3	101	197		62						
Sept. 29	312	485		48						

* Not counted

Workers from widely separate colonies are antagonistic to each other when placed together. Queens were isolated from their workers for seven days and when put together were readily accepted by the workers.

No food has been found stored in the nest chambers of this species. In compound nests, the young of the consorting ant are always available and in isolated colonies final resource is made to their own young when a protein diet is necessary.

Relation to Other Life

Because of the lack of space the relationship of this species to other forms of life is represented graphically as an ecological complex by the accompanying chart. Previously reported facts are given a number referring to literature cited in the appended bibliography. Recent observations made by the writers are not numbered.

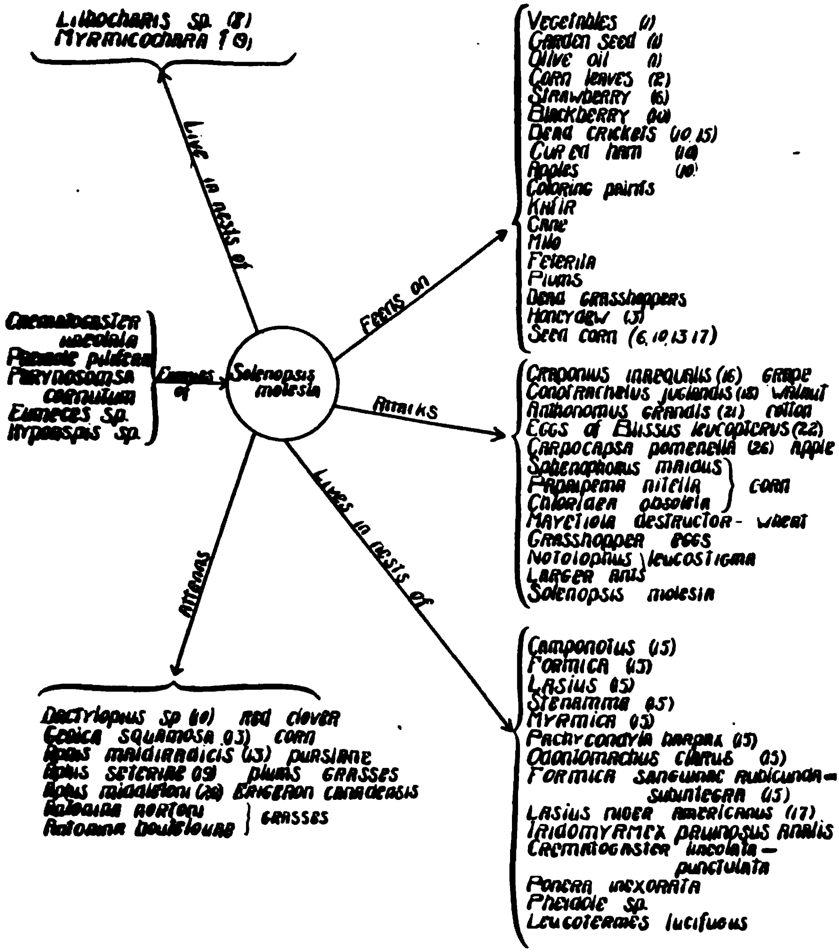


Fig. 1. Chart showing the ecological relationships of *Solenopsis molesta*. References to *Solenopsis debilis* and the American references to *Solenopsis fugax* are included. Numbers refer to bibliography and unnumbered references are original observations.

Natural Enemies

A glance at the list of injurious insects upon which this ant feeds shows us that, notwithstanding its injurious habits of destroying crops and in some places infesting houses, it is to be regarded as a beneficial predaceous insect, which is in turn preyed upon by other forms.

Spiders often trap the workers in their webs. Two other ants—*Cremastogaster lineolata* Say and soldier ants of *Pheidole pilifera* Roger—

were both observed killing workers. The common horned-toads (*Phrynosoma cornutum* Harlan), upon examination of their stomach contents, were found to have eaten numbers of *molesta* workers. In a single stomach of a skink (*Eumeces* sp.), one *molesta* worker was found. A small mite (*Hypoaspis* sp.)[1] which is probably ectoparasitic was repeatedly taken on workers, queens, and eggs. No endoparasites are known.

Methods of Control

The earlier investigations of this ant brought out the fact that the ants ceased to seriously injure the plants shortly after the seed germinated and that the measures of control must be of such a nature as to protect the seed between the time of planting and germination or to hasten germination, or both. A general study was made in 1912 of the agricultural methods practiced in planting sorghum crops, particularly as to the preparation of the seed bed and the manner and time of planting. A large number of farmers were interviewed, forty or more fields were examined, and many experiments were conducted.

From the data thus collected four methods of procedure were suggested for the protection of the seed between the time of planting and germination. These were fall plowing, early planting, surface planting, and treatment of the seed with some repellent.

Fall Plowing.—Fall plowing or listing aids in preventing ant injury by putting the ground in better condition for the germination of the seed. It allows the soil to accumulate more moisture and makes it much easier to prepare a seed bed in the spring. Every measure which tends to hasten germination reduces the amount of ant injury. This practice will also break up any nests of *Solenopsis molesta* that may be in the field.

Early Planting.—During 1911 and 1912, it was noticeable that all reports of injury were coming from late planted fields while the early planted fields showed practically no injury. Field investigations at this time, together with the general experience of the farmers consulted, brought out the fact that early planted seed was rarely if ever materially injured, especially if it was surface planted. In all the fields where injury was reported during these two years, it was found that the crop had been sown after May 20 and in many cases as late as June 1. The established time for planting kafir in southern Kansas, as determined by the Kansas Experiment Station and the United States Department of Agriculture, is about ten days after corn planting time or about May 10. It has been the custom throughout much of southern Kansas to put off kafir planting until the last thing.

[1] Determined by Nathan Banks.

Surface Planting.—Surface planting was first brought to our attention in 1911 on a farm near Hackney, Kansas. At this place twenty-five acres had been planted to kafir. Ten acres of this had been surface planted and the remainder listed. This field was examined June 7 and almost a perfect stand was found on the surface planted part of the field. The listed area had been planted three times and showed less than 50 per cent of a stand. The only explanation for the difference in stand was due to the method of planting. Further investigations have been made each year concerning this method of planting and the data thus far accumulated show that very little injury has occurred on surface planted fields, especially when the planting is made on or about the optimum time to plant kafir.

Surface planting has several advantages over listing and many of the experiments carried on in the area where the soil does not blow show that it is a little more preferable. Kafir seed needs a warm soil to germinate and unless the soil is warm it will lie in the soil many days giving the ants more time to work on it. It often happens in this case that the seed rots or decays if the soil remains cool too long. Surface planting provides a warmer seed bed and consequently greatly hastens germination. Kafir is often washed out or drowned out by heavy rains washing down the lister furrows or by standing in these furrows.

Repellents.—One of the measures of control that early suggested itself was that of treating the seed with some repellent that would keep the ants away until the seed had germinated.

In 1912, the senior author conducted a number of experiments in the vicinity of Derby, Kansas, to determine the value of various repellents against the kafir ant. In one experiment ten plots of kafir were planted in a field badly infested with ants, using kerosene, turpentine, "Black Leaf 40," oil of lemon, camphor, refined carbolic acid, crude carbolic acid, and two brands of commercial chicken dip composed largely of crude carbolic acid and creosote. These plots were visited a week later and the results of this experiment are shown in Table III.

Table III. Results of Dipping Kafir Seed in 1912

Treatment	Per Cent Germinated	Remarks
Dipped in kerosene	10	A few ants present.
Dipped in turpentine	10	A few ants present.
Dipped in "Black Leaf 40"	40	No ants present.
Dipped in oil of lemon	5	Ants numerous and in grains.
Dipped in camphor	5	Ants numerous and in grains.
Dipped in refined carbolic acid	0	No ants present.
Dipped in crude carbolic acid	87	No ants present.
Dipped in commercial chicken dip	92	No ants present.
Dipped in commercial chicken dip	91	No ants present.
Check	2	Ants very numerous.

The result of this experiment indicated that crude carbolic acid or any stock dip composed largely of crude carbolic acid and creosote would practically protect the seed. A number of farmers who had followed this experiment immediately began treating their seed with these substances and in every case they obtained an excellent stand.

The results of the work in 1912 were so promising that in 1913 crude carbolic acid and commercial dip, composed of carbolic acid and creosote, were recommended generally and many hundreds of acres were planted with treated seed. Many of the fields were visited later and in every case an excellent stand of kafir had been obtained. The lowest germination reported by any farmer was 75 per cent.

A continuation of the experiments in 1914 began to show many varying results. In many cases very few seeds would germinate when dipped in crude carbolic acid and in other cases the treated seed germinated as well or better than the check. Table IV gives the results of a number of germination experiments conducted during 1914.

TABLE IV. SHOWING EFFECT OF CRUDE CARBOLIC ACID ON GERMINATION OF SEED

Seed	Date	Per Cent of Germination		Check
		Dipped and Planted	Dipped and Dried 24 Hours	
Kafir	May 4, 1914	28		84
Kafir	May 22, 1914		23	32
Kafir	May 31, 1914	28	49	37
Kafir	May 31, 1914	28	36	69
Kafir	June 1, 1914	28		27
Kafir	June 8, 1914	19		41
Kafir	June 23, 1914	23		23
Kafir	July 11, 1914	7		3
Kafir	Jan. 26, 1915	25	4	15
Kafir	Jan. 26, 1915	31	10	33
Cane	May 22, 1914	35		48
Cane	June 1, 1914	35		29
Cane	June 10, 1914	19		38
Cane	June 23, 1914	12		7
Feterita	May 4, 1914	77		68
Feterita	May 22, 1914		62	92
Feterita	June 1, 1914	75		75
Feterita	June 10, 1914	33		76

In each case one hundred seeds were dipped in crude carbolic acid and either planted at once or allowed to dry for twenty-four hours. The results in this table are taken for a series of several hundred germination experiments and are typical of the results obtained. It is noticeable that there is a wide range in the per cents of germination in the treated seeds and that this is also true in the checks. There is

no doubt a number of factors which influence the variability in the rate of germination and the results thus far obtained indicate that this measure of control is still in an experimental stage and cannot always be relied upon. A study of the factors entering into this variability of germination indicates that the vitality of the seed has much to do with it. The seed used in the 1914 experiments came from the crop of 1913. The prolonged drouth of 1913 greatly reduced the vitality of the seed and it was difficult to obtain a high germinating quality. Mr. B. S. Wilson, of the Agronomy Department of the Kansas Experiment Station, stated to the writers that it was very difficult to obtain sorghum seed germinating as high as 80 per cent, most of the seed germinating much below this and some of it was as low as 4 per cent. A glance at the results obtained in the check plantings will show the low germination of the seed used. The year 1914 was also very dry and the quality of seed was but little better than 1913 so that it has been impossible to continue the germinating experiments further. A large number of other repellents have been tried and some promising results have been obtained. Kerosene and turpentine have been found somewhat effective in repelling the ants but only for a short time as the odor soon leaves the seed. "Black Leaf 40" has been tried in a large number of germination tests during the past two years and in no case has it injured the germination of the seed materially. Little data have been obtained as to its effect as a repellent but in a few cases where it was tried it has given favorable results. These experiments on the effect of repellents on the germination of the seed and the protection against *Solenopsis molesta* are being continued and it is hoped that more definite results can be given later.

Summary of Measures of Control.—From the data thus far accumulated the most practical measures of control against the kafir ant in southern Kansas are:

1. Fall plow the land.
2. Work the field thoroughly in the spring with a disk or harrow.
3. Surface plant the crop.
4. Plant early. This should be about May 10.

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President Glenn W. Herrick: We will now listen to a paper by Mr. M. P. Somes.

SOME INSECTS OF SOLANUM CAROLINENSE L., AND THEIR ECONOMIC RELATIONS

By M. P. Somes

Solanum carolinense L., or, as it is commonly called, "horse nettle," is among the most common weeds of Missouri, as also through a large part of the United States. It is in close botanical relationship with a large number of cultivated plants as tomato, potato, peppers, and tobacco. It is congeneric with *Solanum rostratum* Dunal, the Buffalo bur, from which we have, by transfer of food plant, one of our most serious pests of potato, *Leptinotarsa decimlineata* Say.

During our field studies we noted a series of very interesting insects on the horse nettle. Recalling the natural transfer, mentioned above, from an insect beneficial to man feeding on and destroying a noxious weed, to a serious pest feeding on an important cultivated plant, we were led to test transfers of certain of these insects. The dividing line between beneficial and injurious insects is determined by man's interpretation of the insect's activities. A large number of insects are feeders on varied plants, sometimes even in different families, so that a form of injurious status in one locality may possibly be reckoned as beneficial in another. During the summer of 1914, I noted a natural transfer of this sort which resulted in a harmless species suddenly developing into a pest inflicting serious injury to tomato. This was in the case of *Jalysus spinosus* Say, a common and widely distributed Berytid bug, heretofore considered as of no economic importance. The data concerning this bug have already been published (Mo. State Fruit Exper. Station, Bul. 24, pp. 16–17) but may be briefly summarized here. In July, 1914, a lady living near St. Louis wrote me that her tomatoes were being seriously injured by what she surmised was a mosquito. Visiting her place, I found numerous specimens of this slender, mosquito-looking bug. The injury is due to the puncturing of the fruit stems and the ovaries of the flowers, the common result being that the stems die beyond the puncture and the flowers when injured soon blacken and die. We have noted this injury at various times but thought it due to some form of tomato blight. In the California *Monthly Bulletin* for July 1914 the following note occurs: "At this season of the year many tomatoes fail to set fruit. Vines blossom well and appear thrifty. However, the blossoms, after hanging on the vines for a time, fall off, leaving a part of the peduncles attached to the stem. The cause is a fungus which causes late blight of potato and fruit spot of tomato." This description is exactly typical of the in-

juries resulting from the work of *Jalysus spinosus* and, venturing a guess, we would expect to find that at least a part of the injury is really due to the work of some Berytid bug. During the past two years this insect has worked widely through Missouri and in some districts, where tomato-raising for canneries is of importance, has occasioned serious loss. There are from three to four broods a season in Missouri and the adults pass the winter hibernating beneath leaves and other waste. The adults in feeding assume a most peculiar position of the beak which we have been unable to explain. The first joint is carefully worked into the tissues, then the basal joint is bent backward at an angle of nearly 45 degrees, the second extending horizontally to join the two outer joints at a wide angle. Despite this position which appears but poorly adapted for suction the insect feeds this way for long periods.

Sesia rileyana Dry.

Early in August, 1914, large numbers of the adults of this beautiful little clear-winged moth were found on *Solanum carolinense*. Specimens were sent in to the Division of Entomology at Washington for determination, when Dr. Howard wrote that the life-history was unknown. Hence in spring search for the larvæ revealed them in the stem of this weed and when found May 24 they were in about the third instar. The adults are slender-bodied, clear-winged moths, with the front wings very slender and rather broadly margined with fuliginous and with a red bar at the disk. Palpi and ventral portions of thorax are yellow while the thorax above is shining black. The abdomen is black with six narrow yellow transverse bands. Legs yellow save at the knees where they are brownish. The larva is subcylindric, sparsely pubescent, and rather similar though smaller than that of the common peach tree borer, *Sanninoidea exitiosa* Say. It bores in the central part of the stem, working downward to the roots and passing down one of the main branches at about the time it matures, bores out of the root into the soil. The pupa is formed in the soil, sometimes at a distance of three inches from the stem. The pupa itself resembles that of *Sanninoidea exitiosa* but instead of being surrounded by a gummy cocoon of chips and frass as with that insect, it is enclosed in a slender silken tube from one and a half to over two inches in length. The great mass of the moths emerge from the middle of August to about the middle of September. Our data as to wintering is as yet unsolved. For two years we have noted the mass emergence in August and September as mentioned, yet this summer we took scattered specimens of adults on June 30, July 1, 19, and 28. The specimen taken July 19 was placed in a cage with a growing plant of the

horse nettle and promptly began oviposition. The female clings to the petiole of a leaf with the abdomen touching the main stem. The slender and transparent ovipositor is extruded and the eggs are deposited singly or in groups on the stem. The eggs are oblong ovate, the upper surface broadly concave and the surface hexagonally ridged, the ridges fainter on the concavity. The color at first is nearly white, changing rapidly to a smoky black, the ventral surface remaining lighter. From these scattered adults throughout the summer we must assume a very irregular breeding period. In some of our experiments early in September, several plants of the horse nettle were taken up, together with squares of soil averaging about ten inches across. These were then placed in cages and watched for emergences. In a couple of days a male moth emerged from one of these squares. This was placed in another cage with a newly emerged female. Within fifteen minutes the pair were united, facing in opposite direction and remained in copulation for about an hour. Later examination of the plant in this cage revealed a total of 63 eggs attached to the stem and under side of leaves.

Transfers to Tomato and Potato.—To test the behavior of larvæ on other plants related to *Solanum carolinense*, we introduced them on the stems of tomato, potato, *Physalis pubescens* L. and *Solanum nigrum* L. The transfers were made by taking larvæ from stems of the horse nettle in June and placing them on stems of the desired host plant at places which had been slit or punctured. In every case they showed not the slightest hesitation, but promptly went to work and were soon out of sight. One little fellow, which was not carefully placed, fell off to the soil below where he was noted wandering aimlessly about twelve hours later but when placed in position again, he had worked his way into the tissues within three hours. Varying numbers, from two to six larvæ, were introduced into a single stem but in no case where the stems were spilt and examined in late August were more than two larvæ found alive. The growth in both potato and tomato and Physalis was perfectly normal and larvæ taken from these in August were vigorous and healthy and comparable in size with those taken from field plants of the horse nettle. In the case of Black Nightshade, *Solanum nigrum* L., however, every larva had died and in most cases before it had bored over an inch. In tomato and potato some borings were over eighteen inches long.

Climatic Experiments.—Noting the superabundance of adults in the fall of 1914, after a season of exceptional drought, we arranged a series of cages to give a rough test as to the effect of seasonal conditions on the growth of the larvæ. The cages used were of galvanized iron, 16 by 16 by 20 inches. Those of Series A were open-screen cages of the

ordinary type and well open to air. The plants and soil in these was kept well moistened during the whole period and the plants made fine growth and excellent color. The cages of Series B were similar to the first but with glass sides and top. In each were suspended two light porous cylinders filled with lime chloride. These cylinders were frequently removed and dried. Moisture was supplied to the plants in these cages by a sort of subsoil irrigation system devised as follows: The upper two inches was of ordinary compact soil, below this was two inches of sand and below this a mixture of soil and sand. From the sand layer, or aquifer, a one-half-inch tube extended up one side of the cage through which water could be supplied to the roots. Every effort was made to simulate the conditions of a drought. The growth of the plants in these cages, while fairly good, was not so vigorous or so deep in coloration as in Series A. Examination of the stems of plants thus grown led to the conclusion that the borers thrive best under conditions of drought. This was fully borne out by field records for the past two years. The fall brood of 1915, after a season of exceptional rainfall, was notably smaller than that of 1914, after a season of exceptional drought.

Cassida pallidula Boh.

Among the other interesting insects noted commonly on *Solanum carolinense* L. was this beautiful pale green, deeply pitted tortoise beetle. The larva is of the type common in the group, with its curious anal forks bearing an umbrella of excrement above its back. Larvæ were abundant on wild plants of the horse nettle and on June 30 a number were placed on both tomato and potato in separate cages. They began feeding at once and on July 9 pupation occurred, the adults emerging on the 14th. On July 15 copulation was observed on tomato and on the 17th eggs were found on the plants in this cage, while on the 19th eggs were also found on potato. The eggs are subcylindric, slightly flattened ventrally and with rounded ends and are enclosed in transparent sheaths. They are green in color at first, soon changing to brown. The eggs hatched in from 9 to 13 days and the larval period of the second brood was about one month. The pupation period was from 6 to 10 days.

Gargarphia solani Heid.

Another abundant and interesting insect on the horse nettle was this Tingitid bug, which, unknown to us at the time, had been recently discussed by David E. Fink in U. S. D. A. Bul. 239, where it is called the "Egg Plant Lace Bug." Since our data has been largely anticipated by this paper we will touch but briefly upon this insect. Specimens were transferred to both tomato and potato in separate cages

and watched there as also on horse nettle. The leaves soon showed innumerable black spots marking the feeding punctures, and, in the cases of tomato and horse nettle, soon turned yellow. Egg clusters noted on the plants hatched in from 8 to 9 days. Fink reports that his averaged 6 days but the difference is doubtless due to the fact that last summer was cooler than the summer of 1914 when his studies were made. For more complete data on this insect I would refer any one interested to the bulletin above mentioned.

The species listed above, though feeding and breeding on this very common weed, have been successfully transferred to both tomato and potato and have made good growth on both of these economic plants. If entomological prognostications are in order at this time it is probable that we may look upon these insects as possible pests on one or both of these plants under favorable conditions.

Trichobaris trinotata Say

This well-known pest is far more abundant in Missouri on *Solanum carolinense* L. than on potato and its larva boring in the stems may, at least in the earlier stages, be confused with that of *Sesia rileyana*, but is legless, shorter and more pointed at both ends. Transfers of these larvæ to potato were naturally successful but in tomato, also, when transferred from the horse nettle it was equally at home and entered in a perfectly normal manner, completed its maturation, plugged the boring both above and below itself with sawdust and frass, pupated and transformed to the adult within the boring. The beetles emerged late in September and *remain* in the boring, evidently to pass the winter there in hibernation.

In most texts the statement is made that the eggs of this weevil are laid at or near the surface of the ground but in all our many cages as well as in all our field observations, the eggs were placed in shallow holes gouged out in the axils of the upper leaves or branches and the larvæ gradually worked downward to the base of the stem for transformation.

Epitrix fuscula Crotch and *E. cucumeris* Harr.

Both of these flea beetles were noted abundantly on horse nettle as also on both tomato and potato, readily transferring their affections from plant to plant without any of our assistance. While our studies on these are far from complete yet we have data which indicates at least three broods per season in Missouri.

Phlegethontius carolina Linn. and *P. quinquemaculata* Haw.

These two common Sphingids were both taken on the weed under study and were readily transferred to both tomato and potato. When

we transferred *P. carolina* from horse nettle to tomato they unanimously changed from green to black at the first moult and we felt quite satisfied that this change was due to the change of food but just at that time we happened to bring in the same species from our tobacco and placed them on growing tobacco in our cages, when they just as promptly and just as unanimously moulted to black.

Another insect which we took on several occasions from this weed was a very peculiar elongate Lygæid bug, *Ischnodemus fallicus* Say, this with two leaf-rollers are still under study. One of the leaf-rollers transferred to tomato passed through its maturation and is now in pupa.

President Glenn W. Herrick: I would like to ask Mr. Somes if these insects were found living on these weeds.

Mr. M. P. Somes: The study is based on twelve or fifteen insects found on this weed and was undertaken because of its close botanical relationship to so many important cultivated plants.

President Glenn W. Herrick: It seems to me that studies of this kind are very important and that more information on our common native weeds might be very useful. The next paper will be read by Miss Edith M. Patch.

CONCERNING PROBLEMS IN APHID ECOLOGY[1]

By Edith M. Patch

It is apparent enough that in ecological work with an aphid, the fact of first importance to be ascertained is whether a given species is migratory, for, if it have two types of host plants, the problems that concern its life cycle are doubled, though the economic situation may be simplified by virtue of a greater choice in methods of control.

Something of the import of this was recognized by Walker, who, in 1848,[2] published "Remarks on the Migrations of Aphides," in which he records the alternation of food plants of several species with certain economic suggestions. This discussion included the migration of the hop aphid from the plum, *Siphocoryne capreæ* alternating between the willow and umbelliferous plants and a few other leaf-feeding species—the change in food plants not in any case involving any startling change in the habits of the insects concerned.

[1] Papers from the Maine Agricultural Experiment Station: Entomology No. 84.

[2] 1848. The Annals and Magazine of Natural History, Vol. I. Second Series, pp. 372–373.

It remained for Lichtenstein to announce in various publications during the year 1877 his belief that European species inhabiting elm and poplar migrated to the roots of grasses.

Riley (1879[1]) took him vigorously to task for what he called Lichtenstein's "theory" explaining patiently that

Species of the same genus often so closely resemble each other that they are more readily distinguished by their mode of life, or by the galls they produce, than by structural or describable differences; and this holds particularly true of the immature or apterous stages. This fact, taken in connection with what is here recorded and what is already known of the habits of the sub-family, renders it extremely improbable that any of the species subsist at one time on one plant and habitually change, by migration, to another of a totally different nature.

However, two years later we find Riley writing (1881)[2]:

M. Lichtenstein has for some years fully believed that most of our Aphids, and especially the gall-making *Pemphigini*, habitually migrate, in the winged, parthenogenic, female form, from one plant to another, and that the species must necessarily inhabit two different plants before it passes through its full cycle of development. That it is the rule for most of the insects of this family to so migrate is evident from the fact, patent to all who have observed them, that there is a period in mid-summer when most of the species abandon the plants which they so seriously affect in spring and early summer. . . . The fact of migration rests, moreover, on repeated direct observations, and all spring gall-inhabiting species have usually vacated their galls by mid-summer. . . . In fact it is now coming to be well understood, that in this family the habit of the same species in spring is quite different to its habit in the fall, and that in the study of the insects of this family there is opened up to us a new and interesting field for observation. . . . We have for some time since recognized this fact of migration, but have been led to believe from the known facts in the case that the migration was necessarily from one plant to another of the same *genus*. M. Lichtenstein, on the contrary, believes that the change is still more wonderful and that many tree-inhabiting and gall-making species actually have a mid-summer life on the roots of grasses and herbaceous plants. He has recently communicated to us some discoveries that certainly justify his views.

The pioneer work in America in this "new and interesting field for observation" appeared in 1889[3] with the announcement of the identity of *Schizoneura panicola* Thomas and *S. corni* Fab., followed in 1890[4] by a fuller account with details of observations and experimental data showing that *S. panicola* is merely the grass-root form of the ancient Cornus aphid. In this synonomy was included *S. venusta*

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[1] 1879. Bulletin U. S. Geological Survey. Vol. V, No. 1. Biological Notes on the Pemphiginæ, with descriptions of new species.

[2] 1881. The American Naturalist, Vol. XV, pp. 819–820. Migrations of plant-lice from one plant to another.

[3] 1889. Insect Life, Vol. II, pp. 108-9.

[4] 1890. U. S. Dept. of Agri., Div. of Ent., Bul. No. 22, pp. 32–41. The grass-root plant-louse alias the dogwood plant-louse.

Passerini, under which name it had been described from the roots of grass in Europe.

It no doubt took some courage to announce that the well-known dogwood aphid of Europe was the same insect as an equally well known American aphid feeding on grass roots. It is not unlikely that this discovery came with something the same shock to the investigator that the identity of Dr. Jekyll and Mr. Hyde proved to people who had known "both" these men. There was something incredible about such a situation and a touch of timidity here and there in the paper indicates the realization that the problem was a serious matter and that the announced identity of three well-known aphids must not only rest upon facts carefully investigated, but that the data must be published with detail enough to carry the weight of conviction. There was also something humorous about it all. The grass aphids were rascals leading a dual life and at last brought to the bar of justice as is indicated by the title "The grass-root plant-louse alias the dogwood plant-louse."

This piece of detective work, the first of its kind in America, coming as it did when this type of life cycle had not long been recognized as a possibility for the plant-lice, and presented in a manner to put the reader in as nearly first-hand connection with the facts as possible, merits a place in the first rank of aphid investigations of this country.

Perhaps one of the most interesting things about the publication is the way it has been received by American entomologists. In 1894[1] appeared the following guarded statement concerning *Schizoneura panicola*: "This root louse has been identified . . . as an alternate form with a species of the same genus, *S. corni* Fabr., from the leaves of the dogwood (U. S. Department of Agriculture, Division of Entomology, Bull. No. 22, p. 40); but from all available evidence I am not yet satisfied that the species here described as *S. panicola* ever leaves the ground except to fly from the roots of one food plant to those of another."

In 1910[2] a second entomologist wrote of *S. panicola:* "Common on roots of *Panicum*. . . . It has still to be proven that this is identical with *S. corni*."

And in 1915[3] under the caption of *Anœcia corni* Fabricius, a third writes: "The lice completely desert the dogwood early in the summer and go to unknown plants."

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[1] 1894. 18 Rept. St. Ent. Ill., pp. 85–93. The Grass-Root Louse.

[2] 1910. Journal of Ec. Ent., Vol. 3, p. 413. List of the Aphididæ of Illinois, with notes on some of the species.

[3] 1915. Journal of Ec. Ent., Vol. 8, p. 100. Notes on some Colorado Aphids having alternate food habits.

It might be said that due recognition of this work identifying *Schizoneura corni* of dogwood and *S. venusta* of grass roots has been given in European literature (Mordwilko, 1907[1]) and the observations verified exemplifying the adage concerning the prophet and his own country.

However, it is neither in defence of the investigation of 1889 (for it can stand on its own merits) nor in criticism of the sceptical attitude of some of our foremost entomologists on aphid matters (for I realize that there is reason enough for caution), that I have devoted so much space to the case of *corni*. It is introduced into this discussion because it illustrates two phases of a problem with migratory aphids—that is the initial difficulty of the investigator in getting at the facts and the secondary difficulty of other people in accepting them.

Considering the complexities involved, neither difficulty is to be wondered at. Take *tessellata*, the common woolly aphid of the alder, for instance, with its continuous presence during the summer in the form of apterous females and during the winter as hibernating nymphs upon the single food plant—what place has it in its life cycle for a spring and fall migration from and to the maple? It was incredible that the maple leaf *Pemphigus* had anything to do with a species having an all year existence on alder. I watched that situation for four years before I dared publish it, but by that time I was not much disturbed when a kindly entomologist wrote me a friendly letter to explain that I had made a mistake, giving perfectly logical reasons to show that *P. acerifolii* simply had to be a species distinct from *P. tessellata* of the alder. There was absolutely nothing the matter with his logic—but it didn't stop the maple migrations of *P. tessellata*—at least in Maine.

Logically, the most absurd aphid case yet come to light is that of *Schizoneura lanigera*. Why, any entomologist could sit down and write a book of reasons explaining why the woolly aphid of the apple could have nothing to do with the elm leaf rosette. In the face of these reasons I must confess to something akin to a nervous chill when I first made sure that this common apple pest, with its perennially unbroken residence upon apple roots in the form of apterous females and its hibernating nymphs protected about the same tree, possesses a third normal and annual over-wintering form—that is the egg in the crevices of the elm bark from which hatches in the spring the stem mother of *S. lanigera*, the rosette aphid of the elm—the grandmother of the spring migrants to the apple. However, in spite of my own fright (and possibly that of other entomologists as well?), the migrants

[1] 1907. Biologische Centralblatt, XXVII Bd., No. 23. Beiträge zur Biologie der Pflauzenläuse, Aphididæ Passerini, p. 787.

from the elm rosette continue to settle upon apple and their progeny continue to have the characters of *S. lanigera*—at least in Maine. It is going to be interesting, by the way, to see how this species squares itself with that type of life cycle in certain localities. In Europe, for instance, even where the "woolly aphid of the apple" is troublesome, we have no published record of the rosette aphid of the elm. How does it get along there? Sustains itself by continuous parthenogenetic generations? At any rate it has not lost its habit of fall migrations according to the reports of Börner[1] and Reh.[2] Is it possible that it exists on the European elm but less conspicuously than on the American?

But why should it not be a simple matter—the mere finding out whether a species is migratory? Partly because every aphid cycle we learn is as likely to mislead as to guide us with the next species we investigate. We are in the habit of saying, for instance, that we know that *Aphis pomi*, *Myzus cerasi*, and *Schizoneura rileyi* do not migrate because they occur at all times of the year upon a single food plant, respectively the apple, the cherry, and the elm. That in itself is no reason for surety, for *Prociphilus tessellata*, *P. venafuscus*, and *Schizoneura lanigera* each occurs at all times of the year upon a single food plant, respectively the alder, the balsam fir, and the apple, and yet these are all migratory aphids. There is this distinction between these two cases, however, the three species first mentioned occur at all times of the year upon their *primary* food plant and the second three do not—with them it is their *secondary* food plant which harbors them for twelve months of the year in addition to their winter and spring residence upon their primary host. By "primary host" is understood that plant upon which the over-wintering egg is normally deposited and upon which the stem mother and her immediate progeny develop. The "secondary host" is that plant to which the spring migrants fly and from which they return to the primary host. At present I know of no member of the Subfamily *Aphidinæ* which resides for twelve months upon its primary host and in addition migrates for a part of the year to a secondary host. But it would be a rash person who felt safe in the conviction that such a cycle could not be.

Many migratory aphids, to be sure, alternate their primary and secondary host plants at regular intervals, each time entirely deserting the one for the other, thus existing for a part of the year only upon each. *Rhopalosiphum nympheae* Linn is an example of such a

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[1] 1909. Die Blutlausplage und ihre Bekämpfung. Kaiserliche Biologische Anstalt für Land- und Forstwirtschaft. Flugblatt Nr. 33, p. 2.

[2] 1913. Neues von der Blutlaus. Der praktische Ratgeber im Obst- und Gartenbau. Nr. 5, p. 44.

cycle with its winter and spring habitation on the plum and its summer residence upon various water plants.

Aside from the idiosyncrasies of the aphids as regards their life cycles, their careers are difficult to follow on account of their elusiveness. A species needs to be *very* abundant, indeed, in order to give a field demonstration of its migratory actions. During ordinary seasons it is like looking for a needle in a haystack to obtain field data, even when you know what vegetation to watch.

And the difficulties are not by any means eliminated by bringing the material into the laboratory. Aphids are exacting—they must have succulent food plants with a good supply of sap or a "hunger strike" ensues which means death to the colony and very likely an indefinite postponement of the solution of the problem. Migratory tests ought to be proved out on plants grown from the seed to be absolutely sure of clean stock. Where this is impossible, the test plant should be brought into the greenhouse at least several weeks before migration begins, for two reasons: To secure uninfested material, and to give it an opportunity to get well rooted and ready for growth. It is not an easy matter to grow indoors some of the most common weeds under control conditions satisfactory to the demands of the experiment. I have had repeated failures (and but one success) trying to establish *cardui* migrants from plum upon thistle apparently only because I have not mastered the art of growing a healthy thistle under an aphid cage.

Even aside from the question of the health of the plant, there seems often to be an individual immunity of certain plants against aphid attacks. It is no uncommon thing to find one Norway spruce free from galls of *Chermes abietis* although its branches may touch a second Norway spruce heavily laden with these growths. One spring I stocked about sixty apple seedlings with *lanigera* migrants from elm rosettes and vigorous colonies were secured on but two of them.

Again different species vary exceedingly as to the behavior of their migrants. Some species, it is true, will plunge their beaks into the proffered food plant within a few hours and begin to establish their colony of young the first day and all is placid and straightforward. Other migrants, when removed from their primary host, will rest for a day or two or even longer quietly upon the leaves of anything that is offered them, and then suddenly, when the hour for flight has arrived, they take to their wings and fly as energetically away from their proper food plant as toward it, for it is their instinct to fly, and fly they must before they settle. Others are manageable when handled in small numbers and will settle quietly under such circumstances when they become excited if introduced into a cage in large numbers, and

desert their proper secondary host, evidently instinctively trying to find vegetation at a distance from their sister migrants where their progeny will not lack for ample supplies. Others, which may be too restless to work with in bright daylight, become docile at dusk.

For these and many other reasons it becomes evident that a failure with a migration test gives no data.

If an investigator fails in one hundred attempts to colonize thistle with migrants from plum that will not be a safe reason for him to conclude that he is not working with *Aphis cardui*, or that this thistle aphid has nothing to do with the leaf deformations of the plum in the spring. It has been my own experience that negative data with aphids under such conditions are just no data at all. If the structural characters are such as warrant the migration test in the first place, they warrant a patient continuation even in the face of repeated failures.

On the other hand (and this is the most encouraging and stimulating circumstance in connection with aphid migration tests), a single success goes a long way to prove the case. Barring complications, a single success is enough, and repetitions and verifications are needed only as safeguards in that respect. For these insects are remarkably stable as to their exclusive tastes in vegetable juices and a given species will die before it will submit to the sap of any plant not on its approved dietary. So if the progeny of the migrants accept the food plants given them in the laboratory to the extent of developing upon it from the first instar to maturity, it is safe to conclude that that food plant is one which they would accept in the field under favorable conditions, even though, with the wider choice of the open, a different one might be given preference in certain localities. Such proof should rest with the behavior of the progeny of the migrants and not with the migrants themselves, for the migrants, as has been suggested, have many ways of tantalizing the hopeful investigator.

Since the real proof of the validity of a tested food plant rests with the ability of the progeny of the migrants to develop upon it, it is much simpler to work with the spring migrants than the fall, return forms when dealing with the Pemphigini for the reason that it is easier to be sure that the immediate progeny of *Pemphigus bursarius*, for example, are developing upon the roots of lettuce than it would be to be sure that the stem mothers causing *bursarius* galls in the spring are hatched from eggs deposited by the progeny of the return migrants from lettuce the fall before. Aside from the fact that there are likely to be fewer complications with the spring forms, with many species it is often easier to locate and obtain abundant material in the spring.

But after all there is no set of rules for migration tests with aphids. It is perhaps only a matter of time and patience. The present national policy of watchful waiting applies as appropriately to the small affairs of the aphid as to larger matters.

President Glenn W. Herrick: We will now listen to a paper by Mr. R. D. Whitmarsh.

LIFE-HISTORY NOTES ON APATETICUS CYNICUS AND MACULIVENTRIS

By R. D. Whitmarsh

Apateticus cynicus Say

This is one of our largest and most common predaceous, brown stink bugs. Unlike its near relative *Apateticus maculiventris*, it is but single-brooded. These bugs deposit but a single egg mass, according to my records, which consists, as a rule, of about forty-five eggs. The eggs are laid in late fall and the young emerge from these eggs anywhere from the middle of April to the middle of May, depending on the season. The eggs are of a reddish-brown color, barrel-shaped, and measure about one-tenth of an inch in height by one-sixteenth of an inch across. Like other pentatomid eggs, they are provided with a lid-like cap around which are about twenty short, club-like processes. At the time of hatching this lid lifts and a light reddish colored insect emerges which soon becomes dark red with black head and thorax and black spots along the dorsal portion of the abdomen. The length of time spent in the different instars depends greatly on the amount of food which the bugs are able to find. Under favorable conditions they will pass through the various immature stages and become adult in a little over a month and a half. Under unfavorable conditions they may not reach maturity in less than two and a half months. Following is the approximate time which elapses when the insects occur under favorable conditions: From the time of the hatching of the egg to the first molt, 5 days; second instar, 5 days; third instar, 1 week; fourth instar, 2 weeks; fifth instar, 3 weeks. Under our conditions of climate the majority of the insects become adult between the middle of June and the middle of July. Ordinarily, mating takes place from two to three weeks after the insects become adult, and continues at intervals throughout the remainder of the summer. The males usually commence dying off about the first of September, while the

females commonly outlive the males, sometimes several weeks, when they deposit their eggs and die. This large species is a very voracious feeder from the time it reaches the second instar until maturity and death. It will even feed on its own mates when crippled or in any way unable to protect themselves. This is especially noticeable when molting, for at this time the insect, for a short period, is practically helpless. Their food consists mainly of caterpillars of various kinds. For a short period records were kept of the numbers of caterpillars these insects would kill. My first experiment was with a male and female. Following is the record of the caterpillars killed by the two insects between July 24 and August 17, 1913:

July 24................	*Datana integerrima*	4 caterpillars	1 inch long.
July 26................	*Halisidota caryæ*	4 caterpillars	1 inch long.
Aug. 4.................	*Datana integerrima*	4 caterpillars	1 inch long.
Aug. 8.................	*Datana integerrima*	4 caterpillars	1 inch long.
Aug. 11................	*Datana integerrima*	4 caterpillars	Nearly full grown.
Aug. 16................	*Callosamia promethea*	1 caterpillar	1½ inches long.

In another feeding experiment, using two adult males, between July 24 and August 15, 23 caterpillars were killed.

July 24................	*Datana integerrima*	4 caterpillars	1 inch long.
July 30................	*Datana ministra*	4 caterpillars	Full grown.
Aug. 4.................	*Achemon sphinx*	1 caterpillar	Full grown.
Aug. 8.................	*Datana integerrima*	6 caterpillars	Full grown.
Aug. 11................	*Datana angusii*	4 caterpillars	Full grown.
Aug. 15................	*Datana integerrima*	4 caterpillars	Full grown.

Apateticus maculiventris Say

These insects commence laying eggs under ordinary climatic conditions the latter part of May, or early June. The eggs are of a brownish-black color with a metallic luster, and measure about one-sixteenth of an inch in height and about one-third less across. They are oblong, oval in form, each being somewhat tapered at its base or at the point at which it is cemented either to leaf or bark. The top of the egg is quite broadly rounded, surmounted by a cap, around which is a circlet of about fourteen hair-like spines. At the time of hatching, this cap-like structure is pried open by the emerging insect. The number of eggs laid by a single individual varies to some extent. Commonly, the egg-laying period extends over two or three weeks, during which time the female deposits several clusters of eggs at intervals of a day or two between each laying. My records show that some insects deposit but three groups of eggs, while the greatest number was nine, deposited between June 28 and July 17, 1913. The most common number of eggs deposited at a single time is from 20 to 30. Thirty-five eggs is

the largest record I have for a single mass. These eggs hatch at the end of three days and the little, blood-red insects with black head and thorax remain massed together beside the egg-shells for three days with apparently no desire for food. At the end of this time they molt and at once start out in search of food, which consists for the most part of small, larval forms of insects. At the end of six days they again molt. The third instar lasts from four to five days, fourth instar from four to six days, and the fifth and final instar from seven to ten days. Under our conditions, we have from four to five broods per year. These insects are entirely predaceous, except possibly to a slight extent during the first instar when they may suck plant juices if they feed at all, which thus far is unproved. By nature they are very greedy, and kill many of our common insect pests when given the opportunity. During the early part of their life they show their preference for small insects such as aphids and recently hatched forms of beetles, moths and butterflies. I have found them feeding on almost every common form of caterpillar, the larval forms of beetles such as the elm leaf beetle, poplar leaf beetle, potato beetle, etc. I will say, however, that they show a great dislike to hairy caterpillars, such as the fall webworm, etc., and seem unable to exist on such food. The winter is passed in the adult stage in some sheltered place.

President Glenn W. Herrick: The next paper will be read by Mr. H. A. Gossard.

THE DISTRIBUTION OF THE PERIODICAL CICADA IN OHIO

By H. A. Gossard

Three cicada years have occurred since I came to Ohio, and the accompanying maps show as accurately as I have been able to determine, the present distribution of the broods of 1906, 1914 and 1915. The brood of 1911 was due to occur in Hamilton County and that of 1912 in Champaign County according to Bul. 71, Bur. of Ent., U. S. D. A., but I have no data whatever to indicate whether these waning broods appeared according to schedule, or have become extinguished.

The map for the 1906 brood, or brood XIV of septendecim, according to Marlatt's numbering, is based upon 109 report cards; 55 of which recorded the presence of the insect and its general distribution in the counties of the reporters, and 54 of which recorded its absence. Most of the latter reports came from parties outside the zone of occurrence and served to fix, quite satisfactorily, the boundaries of the

brood. The dots on this map are distributed to show the areas infested and have no relation to the number of reports received. The squares indicate the presence of swarms. The crosses report absence of the cicadas. The following counties were found infested: Adams, Brown, Clermont, Clinton, Fayette, Gallia, Greene, Hamilton, Highland,

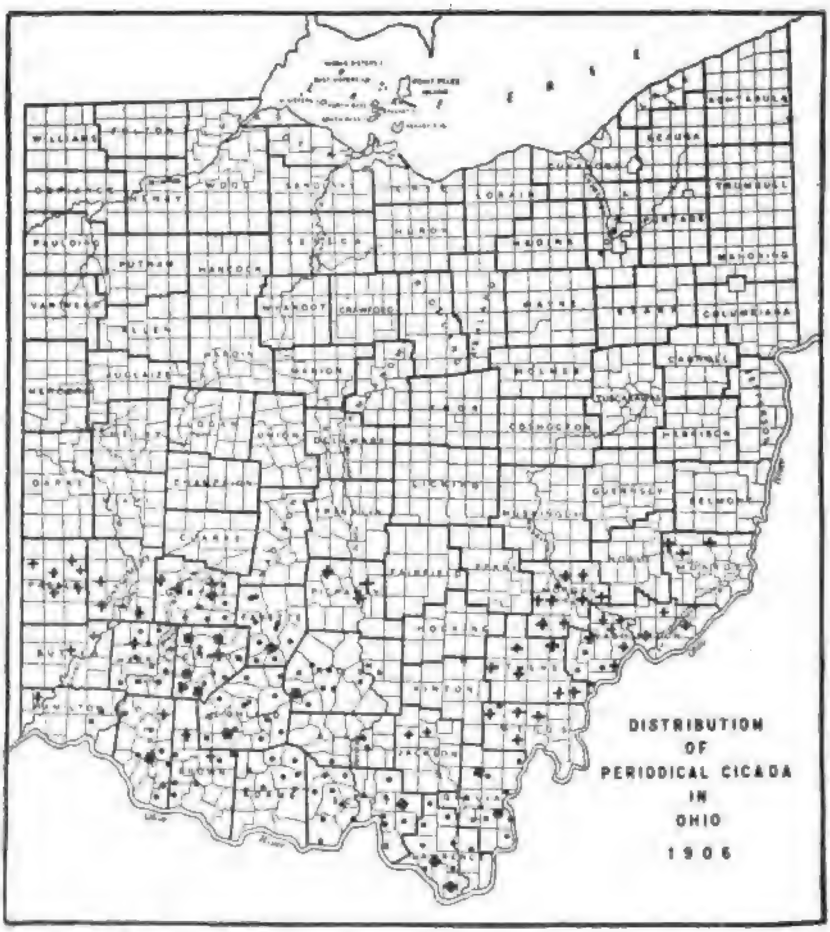


Fig. 2

Lawrence, Meigs, Morgan, Pike, Ross, Scioto, Vinton, Warren, Washington.

From the following counties, listed in Bul. 71, Bur. Ent., as occupied by the brood, I secured no report, but in all likelihood the insects appeared in some of them: Auglaize, Butler, Columbiana, Cuyahoga, Delaware, Jackson, Preble.

The map for the 1914 brood, or brood V of Marlatt, is constructed from 1,199 reports gathered respectively by the Experiment Station, 699, Ohio Division of Nursery and Orchard Inspection, 442, and the Ohio Biological Survey, 58. My thanks are hereby tendered to Professors Osborn and Shaw for the privilege of including their data

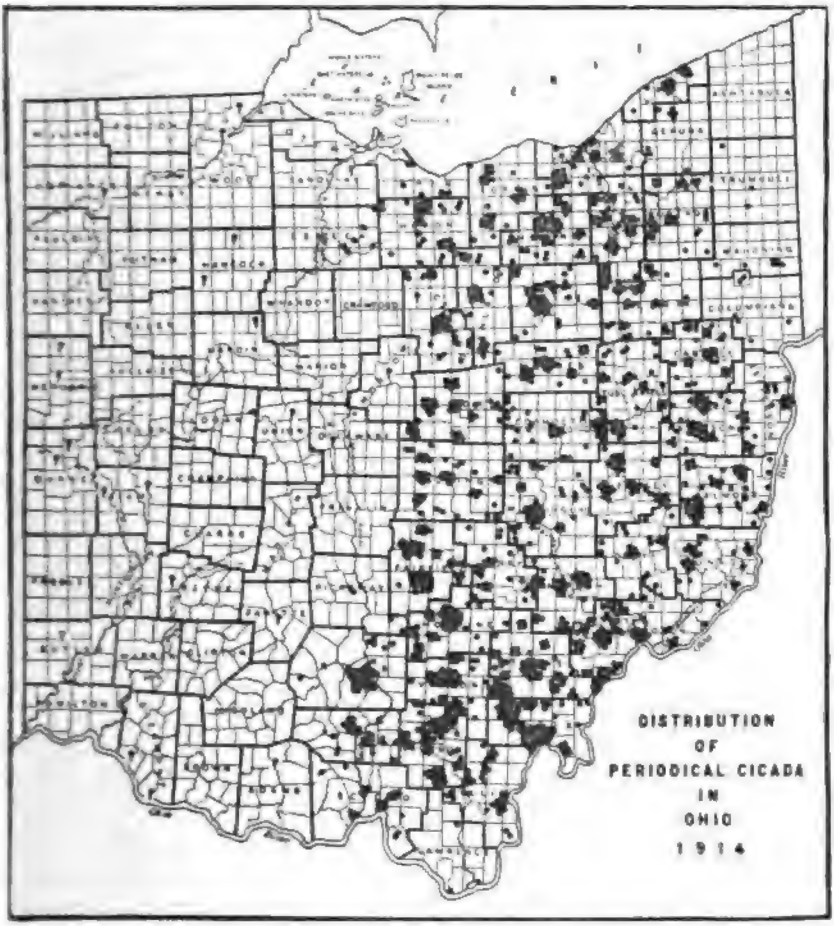


Fig. 3

in this report. Each dot or square represents one report, the whole being an accurate map of the brood. The squares indicate swarms. The accompanying grouping of counties according to latitude shows the respective dates of appearance and disappearance of the brood in the different zones, going from the southern to the northern parts of the state.

DATES OF APPEARANCE AND DISAPPEARANCE.

Counties	Appearance		Disappearance	
	Month	Date	Month	Date
Lawrence	5	15	?	..
Gallia	5	15	7	8
Scioto	5	16	6	30
Pike	5	15	6	20
Jackson	4	1	7	1
Meigs	5	9	7	25(?)
Ross	5	15	6	27
Vinton	5	5	7	4
Athens	5	20	6	30
Hocking	5	10	7	11
Washington	5	1	7	8
Pickaway	5	10	6	14
Fairfield	5	15	7	1
Perry	5	1	7	5
Morgan	5	15	7	6
Noble	5	1	7	4
Monroe	5	1	7	12
Licking	4	12	7	10
Muskingum	5	1	7	11
Guernsey	5	15	7	3
Belmont	5	15	7	3
Knox	5	15	7	22
Coshocton	5	10	7	4
Harrison	5	15	7	15
Jefferson	5	1	7	3
Holmes	4	1	7	10
Tuscarawas	5	15	7	15
Carroll	5	15	7	6
Crawford	6	8	7	1
Richland	5	1	7	13
Ashland	4	20	7	6
Wayne	5	20	7	6
Stark	5	15	7	2
Columbiana	5	30	7	15
Seneca	5	24	7	25
Huron	5	20	7	4
Medina	5	10	7	4
Summit	5	1	7	12
Portage	5	15	6	25
Mahoning	5	30	0	0
Trumbull	5	1	6	6
Erie	5	20	7	10
Lorain	5	1	7	12
Cuyahoga	5	15	7	4
Geauga	5	7	7	1
Lake	5	20	7	20

It will be seen from these reports that the records of first notice were as early in northern Ohio as in the southern part, but the dates of disappearance are progressively later, going toward the north. Since our reporters included pupæ as well as adults in their observations, there was probably a wider difference in the dates for the appearance of the adults in the respective sections than the records appear to show.

The interrogation points in several of the western counties, when considered in connection with what may be called the internal evidence of the report cards, indicate a strong probability that the cicada appears thinly but regularly in several neighborhoods in the western half of the state, entirely outside of territory heretofore mapped as inhabited by the brood.

While pupæ were observed and collected in large numbers at Wooster during the last ten days of April, no adults were recorded until May 25, when I heard their song in the woods about one and one-quarter miles northeast of town. They were plentiful 10 days later and commenced ovipositing June 5 and 6. A young orchard, newly set, had the tree tops covered with mosquito netting and the trunks wrapped with paper, the work beginning June 9 and being finished June 11, but considerable injury was done during the 4 or 5 days when the females were busy. The cost of this protection, including labor for putting on the protectors and later removing them, averaged about 5 to 7 cents per tree, but could have been reduced as much as 2 or 3 cents per tree under normal conditions. Some unprotected young orchards of a year's growth near Wooster suffered very severely. It would probably have paid to have protected them, even at a cost of 25 cents per tree.

Though a careful lookout was kept at Wooster for cicada chimneys, none were observed. Mr. J. L. King and Mr. C. A. Reese reported that at Sugar Grove, Hocking County, in the pine woods east of the Baumgartner farm, were acres of cicada chimneys so thick that one could not step without breaking some of them down.

The cicada adults were still plentiful and musical at Wooster, June 16, but were beginning to decline and by June 23 only a few stragglers were left. At Funk's Hollow, west of Wooster, Mr. S. G. Harry found them singing July 4 and 5, which, with one exception, was the latest record for Wayne County. The latest report was July 6, giving the adults an extreme period of 46 days for Wayne County. July 10, no song could be heard in any of the places where they existed less than a week earlier.

The map showing the distribution for 1915, or brood VI of Marlatt, was constructed from 227 reports of which 38 affirmed the presence of the cicada and 189 denied its occurrence, or else were evidently based on the supposition that some other species was *septendecim.*

I rejected all reports of occurrence after the first few days of July, though there is a possibility that some of the later reports really referred to belated specimens of the 17-year species. The fact that not more than one-fourth of my letters of inquiry brought any response indicated to me that the brood was very thin, and not a single card

Fig. 4

reported a swarm. Nearly all the reports mentioned that only a very few specimens were seen or heard. In fact, if we were to rely upon this season's record alone, we might properly regard all of the insects appearing as stragglers of the 1914 brood. I doubt if they were sufficiently numerous in any part of the state to reproduce. County Agent Galehouse of Mahoning County reported that larvæ came

quite numerously to upper layers of soil in April and May, but did not subsequently appear as adults in any considerable numbers, so far as he could discover. It will be a matter of some interest to watch for their possible appearance next year in his county, since they may have been retarded by cold. Each dot on the map records a report of occurrence, often of only a single individual, or much less frequently of a very few specimens. The record for Wayne County is based on the song of 2 individuals, heard by J. S. Houser and Prof. Edmund Secrest, June 7, 1915; and for Ashland County, on the song of a single specimen heard by Messrs. J. S. Houser and E. B. Forbes at Loudonville, June 9, 1915. The counties containing the remnants of this brood are, according to these meager returns, Ashland, Ashtabula, Carroll, Columbiana, Delaware, Harrison, Madison, Mohoning, Meigs, Montgomery, Morrow, Pickaway, Shelby, Stark, Summit, Union and Wayne.

Comparing with Marlatt's record, Ashland, Harrison, Meigs, Stark and Wayne counties are added to the territory of the brood, and Champaign and Vinton counties fail of confirmation.

(By general consent discussion was deferred until after the presentation of the following paper by Mr. Gossard.)

IS THE HIVE A CENTER FOR DISTRIBUTING FIRE BLIGHT? IS APHID HONEY DEW A MEDIUM FOR SPREADING BLIGHT?

By H. A. Gossard

Seeking an answer to the above questions the following experimental work was performed during the season of 1914, the technical bacteriological work being done by Mr. R. C. Walton of the Station Botanical Department.

Honey and the Hive

Cultures were made from old honey taken from three different hives early in the spring in an attempt to learn if the bacilli of blight were carried over the winter in the hive. Both light and dark honey from each hive was sampled for this purpose. No specimens of the organanism of blight were secured from any of these hives.

In an attempt to definitely connect the hive with the transmission of the disease, cultures were also made, during the apple-blooming period, from five hives into which fresh apple honey had been carried from orchards which had blighted to a greater or lesser degree the

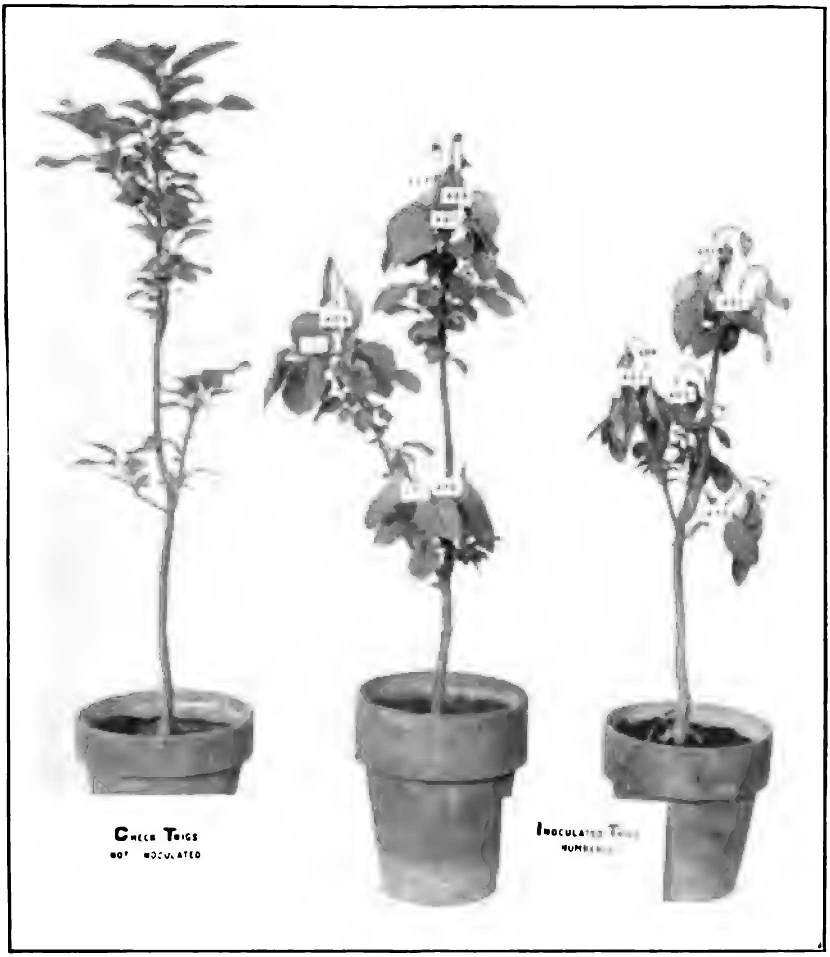
preceding year. These samples, like all others, were sucked from the comb cells into sterilized pipettes and we had the judgment of Mr. E. R. Root of Medina, Ohio, that the samples were largely fresh apple blossom honey with only a little admixture of dandelion. They, therefore, approximated as closely as honey samples could do, the composition of apple blossom nectar in which the bacilli are known to thrive. None of these samples yielded the blight bacillus. However, we do not positively know that blight bacilli were present in the blossoms to which the bees from four of these hives had access; we do definitely know that they were present in a large percentage of the blossoms on which the bees from one of the hives pastured, but from which we obtained no blight, though honey samples were taken from it at intervals up till midsummer.

To determine if it is possible for the organism to live in honey as it does in nectar, and inferentially, that the bacilli can be scattered from the hive, we inoculated with the blight organism samples of sterilized honey, of varying age, from the freshest nectar-like samples we could obtain from the combs to samples taken in midsummer, and then cultured from these samples at intervals for the purpose of determining how long the bacilli would remain virile in this medium. Cultures were made on agar and incubated in the laboratory and then parallel or confirmatory series of inoculations were made into young apple shoots. Both pure honey and 50 per cent honey, diluted with water so as to more nearly approximate the composition of nectar, were used. The number of cultures made was 176 and the number of inoculations made closely approximated 600. Some 400 to 500 check twigs were numbered and examined for comparison. After incubating in honey from 8½ minutes to several days, the organism was cultured by the poured plate and streak methods on 3 per cent neutral nutrient glucose agar. Growth of the organism was obtained from the 8½-minute incubation and also on intermediate incubations up to and including 43 hours and 25 minutes. This isolated organism, when inoculated into the growing tips of apple shoots, usually gave 100 per cent of infection on trees where no infection occurred on check or uninoculated shoots. The inoculated shoots were protected against other means of infection by being enclosed in paraffined paper bags. Some of the inoculations were made into the shoots of small potted apple trees kept growing in the greenhouse and among which no blight had ever existed. The results with these potted trees exactly agreed with those obtained when working with orchard trees.

A fresh culture of *B. amylovorus* was inoculated into a tube of unsterilized honey and incubated there from 4 to 47 hours. At the end of the 4th, the 28th, and the 47th hour, inoculations were made from

Inoculated tree with *B. amylovorus* after incubating in honey for 41 and 42 hours and then grown on 3 per cent neutral nutrient glucose agar.

931–942 Inoculated—100 per cent infected 943–954 Checks—free



Inoculated trees with *B. amylovorus* isolated from pure honey after 8 minutes, 1 hour, and 2 hours and 4 minutes incubation in it and then grown on neutral nutrient glucose agar.

461–473 Inoculated—100 per cent infection

Check tree—free

the infected honey directly into the tips of apple shoots. These inoculations gave 84, 64 and 52 per cent of infection, respectively, as against 0 per cent in the checks kept for comparison. These tests prove conclusively to us that the blight organism, in honey, can remain sufficiently virulent for 47 hours to produce infection, with the extreme time-measure of virulency probably not reached. Tests of this kind were made with fresh apple honey and also with well-ripened honey taken from the hive in midsummer, and the results were substantially the same.

It is evident from these results that the formic acid of honey is not immediately fatal to the blight organism, and, while we may guess, from the fact that we could get no infection after a certain limit of incubation, that the bacilli simply survive for a time without multiplying, we are unable to entirely reject the possibility of their multiplying in the comparatively raw nectar when it is first carried into the hive and has undergone but little of the curing process. Anyhow, we believe we have proved that if one bee carries 100,000 bacilli into the hive one day, that on the following one or two days, each of 1,000 bees has the possibility of carrying a considerable fraction of 100 virulent bacilli out to fruit blossoms, because practically all the bees in the hive are at work during the night curing the honey. This would seem to go a long way toward explaining the wholesale infection that occurs in the latter part of the blooming period. However, it must be remembered that this surmise, as yet, rests upon inference alone.

Aphid Honey Dew in Connection with Blight

From the similarity in composition of nectar and aphid honey dew, the habit of bees, ants and flies to visit it, and also because of the known relation of aphids to blight inoculation, we were interested to learn if blight bacilli could live for any length of time in this as they do in nectar and in honey. Two of the largest drops we could find on rolled apple leaves on potted trees in the greenhouse were infected with blight bacilli, and at the end of 20½ hours, 43 hours, and 71 hours and 20 minutes, young apple shoots of potted trees which had always been free from blight were inoculated, using the infected honey dew as the inoculum. These inoculations resulted in 66⅔, 83⅓ and 100 per cent of infection respectively.

In each important series of inoculations we made it our practice to reisolate our organism and prove the identity of the bacillus by cultures, microscopic examinations and reinoculations.

The habit of ants to visit colonies of woolly aphids, gathered in the spring around old but living blight cankers, and then of visiting the green aphids on the expanding buds, which are in turn visited by some

of the bees and by various flies, in quest of honey dew, may constitute a chain, the significance of which we can only conjecture at present; but, if the chain can be proved, we may possibly possess the key to blight control; at all events, to a more effective control than we have at present.

Mr. T. J. Headlee: I would like to ask why neutral agar was used?

Mr. H. A. Gossard: The technical part of the bacteriological work was done by Mr. R. C. Walton formerly of the Pennsylvania Chestnut Blight Commission. The chief purpose was to isolate the organism so as to obtain a pure culture and have it ready for use.

Mr. T. J. Headlee: Is it likely that this method would increase the virility of the organisms?

Mr. H. A. Gossard: I cannot answer that question.

Mr. E. F. Phillips: Is it assumed from Mr. Gossard's paper that honey bees carry out honey after it has been carried into the hive?

Mr. H. A. Gossard: What we suspect is that the bees, in working over the honey at night which they have gathered in the daytime as infected nectar, become contaminated, the germs clinging to their mouthparts and possibly to their feet and, if so, the question is, will the germs remain virulent during the next one or two days.

These were the questions we were trying to solve. We assume, as a matter of course, that some honey will cling to their mouths and perhaps to their feet and hairs.

Mr. E. F. Phillips: The amount of acid in honey is very small. I should not suspect for one moment that the blight organisms would be killed by the action of this acid. In the case of certain brood diseases, the causal organisms remain for years in honey.

Honey is a fine medium for the preservation of any substance, particularly any bacterial organism. While it is suitable for the preservation of any material I do not see how these facts have any bearing on the pear blight situation for it must first be shown that honey actually becomes contaminated.

Mr. W. A. Riley: The question came up as I understand it regarding the spreading of germs from natural honey.

Mr. H. A. Gossard: No. We made a number of inoculations and cultivated from them in order to prove the possibility of natural honey preserving the germs for a considerable period.

Mr. W. A. Riley: As suggested by Dr. Phillips I would like to know as to whether these germs would pass through the alimentary canal of the bee or whether they might live in the bee. I am curious

to know what would be done in case the latter occurred; whether it might furnish a key to the control of pear blight.

MR. H. A. GOSSARD: I think we would have to go back of the honey bee. In my opinion, the orchardist is dependent on bees whether they scatter blight or not. The question with entomologists and botanists, everywhere, who have watched the blight and have given any time to the investigation of it, is to explain the wholesale infection that comes in early spring just after blooming. We believe it will become necessary to determine where the bees first obtain the germs and break off this supply.

MR. J. H. MERRILL: In Kansas, in 1913, the green aphis was so abundant on the unopened apple buds that several orchardists sprayed and controlled them with a contact insecticide. Later in the season blight was prevalent in many orchards but it was noticed that there was practically none in those in which the aphids had been controlled.

In 1914, the aphids were not as abundant and but little blight was noticed.

In 1915, the aphids were as numerous as in 1913 and, at this time, a large number of orchardists sprayed their trees before the blossoms opened with a contact insecticide to control the aphids. Blight was very bad in Kansas orchards during 1915 but in all those in which aphids had been controlled it was almost a negligible quantity.

As these experiments have been carried on over several hundred acres of orchards and with the same results during three years' time, I feel quite justified in accusing the aphids of being one of the chief distributors of fire blight.

MR. H. A. GOSSARD: We have carried on similar experiments with aphids and have obtained similar results. They are quite important later in the season.

We are very dubious, however, about their being the only offenders.

PRESIDENT GLENN W. HERRICK: Is there any definite data that aphids transfer bacillus?

MR. H. A. GOSSARD: If I am not mistaken some of the men at Cornell have proved that aphids transmit it. Mr. Burrill of Wisconsin has proved it and we have done likewise at Wooster.

I did not care to touch upon that subject in the present paper, as it would be more suitable for a paper published at a later time. We have proved that a considerable number of insects transmit blight.

MR. T. J. HEADLEE: During the season, which has just passed, I have had the opportunity to observe the prevalence of blight in cultivated orchards in comparison with neglected plantings. The damage done by blight was undoubtedly much greater in uncultivated orchards, and this greater damage seemed to be directly correlated

with the greater succulence of the neglected trees induced by the exceedingly rainy season.

It seems to me that the type of cultivation is thus shown to be a factor in the prevalence of blight which may seriously interfere with evidence as to the blight-carrying power of aphis, for under just such conditions as have obtained in New Jersey last season, failure to spray (as would normally be the case in uncultivated orchards) may be followed by aphis and by most serious blight damage without there being any essential connection among them.

President Glenn W. Herrick: If there is no further discussion this completes our program for the session.

Adjournment 4.30 p. m.

Morning Session

Tuesday, December 28, 1915, 10.00 a. m.

President Glenn W. Herrick: The first business on the program is the discussion of the presidential address and I will ask Dr. S. J. Hunter to act as chairman.

Mr. S. J. Hunter: The discussion of the presidential address is now in order:

Mr. F. M. Webster: It seems to me that the subject discussed by the president in his address is a most important one to us all, as it deals with the preparation of entomologists for their life work. It appeals to me particularly because I think I have more entomologists working under me directly than any other one man in the country and I continually find that much depends upon the training of these men. Professor Herrick has covered this subject very well. It is one of the most important ones with which we have to deal.

There are one or two points I would like to mention that will show you another side of the situation. For the most part I think that the men who have been trained are unfitted for their work although I have had some men working under me for a good many years. I would not know how to do the work better and I do not know any way that it can be done better. Some time ago Professor Herrick was selected to mark the Civil Service examination papers covering the entomological examinations for the Bureau of Entomology. I do not believe anyone could have been selected who would have done this more accurately than he has but he has kept me around the Civil Service Commission from the first day of July to the 31st day of December. In the last list of papers that were graded, many men were rated very low who should have been in the front rank, while men who were not

fitted for the work were placed near the top of the list. There is, therefore, no way of telling by an examination what a man's ability really is.

There is something wrong somewhere. That is the situation that we have to face who must use the output of the universities. As a matter of fact I do not care where a man comes from or whether he is an American or not, but I want a man who will do things and will do things no one else is able to do. It is hard work to get such men. Civil Service examinations do not produce them because they are not a satisfactory test of a man's ability.

In making up a staff at a field station I will not have two men from the same state if I can help it. I want men from different institutions who have been trained under different instructors. By arranging matters in this way it is possible to secure the very best that is in all the men. I have eighteen field stations, some of which are rather small. When a young man just out of school is placed with half a dozen men in one of these stations he soon finds out that he has most of his education to get, but being associated with men who are differently trained, he is bound to get a square deal. When it comes to a college absolutely fitting a man for his work they do not do it, and I do not believe I could prepare a set of Civil Service examination questions that would bring out a man's ability.

It seems to me that the instructors in the different universities should get together and do their best to improve upon the education of the entomologists and give them those things which will bring them up to date and make them better acquainted with conditions under which we are working today. Some of my men are doing things that were deemed impossible ten or fifteen years ago. These are the kind of men we must have if we are to make progress. The instructors in the universities act as the producers while we are the consumers. I do not say they are not doing their best and achieving the best results that are possible under our present educational conditions, but some improvements should be made in the future. I have been working with President Pearson of the agricultural college at Ames, Iowa, and hope that the course which is about to be started there will bring about an improvement over some of the courses now given.

Mr. H. A. Gossard: I am sure that the Association in general has not been sitting still because they did not appreciate the President's address. I think he has succeeded in making so good an address that we do not differ from it but have accepted it in its entirety. I am sure everybody has appreciated the experiences narrated by Professor Webster and all of us meet more or less the same problems in the field. We must remember, however, that teachers cannot make over per-

sonality; they can do a great deal to educate, but the peculiarities of the individual cannot be changed. We must fit our problems to our men as well as fit the men to the various problems. We may have with us men who can do certain things and do them well and it is often better to set them doing those things which they can do well rather than to put them to doing things they cannot do so well. We must consider both the workers and the work to be done. The problem of adaptation is a double one.

Mr. S. J. Hunter: The President in his address has touched upon some fundamental points in education, a number of which are receiving serious consideration from other scientific bodies interested in education.

One is whether it is advisable to encourage research work among undergraduate students. In this, I believe the concensus of opinion agrees with the President, that saner and more lasting results will come through research workers who have had a broad and fundamental training before entering the field of research.

Another point which the President dwelt upon, worthy of interest, is that in the teaching of entomology there should be a place for biography,—a study of men noted for the results of their research along biological lines. Their early training, their methods of study and style of presentation can not fail to give an incentive to promising workers.

A third point—that in the education of an entomologist, we should place little weight on the making of a living. A student's first consideration should be the quality of his fitness. Professor Webster, who has preceded me in the discussion of the President's address, has referred to the matter of Civil Service examinations. In this connection, the greatest difficulty we have found is in keeping men from taking these examinations before they were, in our opinion, ready to take up the work which the passage of such examinations assumes that they are ready to do.

Mr. W. A. Riley: I was in a committee meeting and so I did not hear the full address yesterday, but I think I know the viewpoint presented.

I have been especially interested in Professor Webster's remarks because it seems to me that they are comparable to those which are constantly being presented in the teaching work. From the teacher's viewpoint, you hear the complaint about the type of students, the type of preparation for college work. The question as to whether a student should be encouraged in doing this work or that, cannot be considered wholly on its merits, for as teachers we must take the material that comes to us. There is no arbitrary test in the general

educational systems that will do more than weed out a proportion of those unfit. A man may pass formal examinations with high grades and yet be wholly lacking in the most essential qualities which make for success.

As a course of study I believe that it is best to give a man a broad general preparation in entomology and then allow him to decide for himself the field in which he wishes to specialize. Some who come to us are not particularly fitted for any aggressive original work, but this is not a difficulty peculiar to college students of entomology.

MR. S. J. HUNTER: If there is no further discussion we will proceed with the regular order of business.

PRESIDENT GLENN W. HERRICK: We will now pass to the reading of papers. The first paper on the program will be given by Mr. F. B. Paddock.

OBSERVATIONS ON THE TURNIP LOUSE

By F. B. PADDOCK, *Texas Experiment Station, College Station*

Work was first undertaken with this species in the fall of 1913. Previous to that time the numerous inquiries which were received indicated that this insect was becoming very destructive over the entire state. When the investigations were started it was supposed that the insect was the cabbage louse, *Aphis brassicæ*. The statements made in literature at that time were that in the South during the winter the cabbage louse was a serious pest of turnips grown as a winter truck crop.

Very soon after the work was started it became evident that the species under observation was not the cabbage louse. Material was sent to Prof. C. P. Gillette and he determined it as a new species, *Aphis pseudobrassicæ*, just described by Mr. J. J. Davis. This determination was then confirmed by Mr. Davis. As soon as it was certain that the species under observation was not the cabbage louse, we took the liberty of calling it the "turnip louse," as that would identify it more readily for the truck grower.

This aphid has been reported to feed on the following hosts, named in order of importance as determined by our studies: Turnip, radish, mustard, rape, collard, rutabaga, cabbage, kale, kohl-rabi, bean and lettuce. It is quite possible that the presence of this aphid on the last two mentioned hosts was somewhat an accident and it is doubtful if the infestation could have persisted.

The normal form of reproduction in this aphid in Texas is asexual throughout the entire year. It seems that each generation is made

up entirely of viviparous females, as no sexes have so far been observed in the fields or in the cages. The farthest north in Texas that observations were made on this species was Wichita Falls, just south of the 34th parallel. It is evident that at this point sexes do not occur and the viviparous females survive the winter. Mr. Davis has written that the sexes have not been found in their search at West Lafayette, Indiana.

At College Station the winter temperatures are seldom low enough to prevent reproduction, though the daily number of young produced is very small. There are a few days when the lice, especially the old ones, do not reproduce. At Wichita Falls the winter temperatures of 15 to 20 degrees F. are not uncommon and frequently the temperature may remain below 32 degrees F. for five to seven days at a time. Often during the cold spells as much as one inch of snow may remain on the ground for a few days. Under such conditions the lice do not reproduce but reproduction takes place when the warm temperatures prevail. But few lice succumb to the cold at this point, these being the very old lice. At Brownsville, near the 26th parallel, the conditions in January are similar to those which exist at College Station in October. The daily young produced in the fields is four to six.

With the approach of the hot, dry weather of the summer there is a decided reduction in the daily young produced and all stages in the life-history are lengthened, the same as under winter conditions. It is quite evident that the summer conditions in Texas are even more trying than the winter. There are four to five months of very unfavorable conditions during the summer.

In 1914 a first-born generation series was started on January 18 and continued until August 6. During this time twenty generations of lice were born. This work was started again on September 14, 1914, and continued until the same date in 1915. During this period of exactly twelve months, thirty-five generations of lice were born. The average total young produced by the generations of the first series was 80, by the second 93.

Two other species of aphids were found to feed on the same host plants as the turnip louse. These are the cabbage louse and the "garden aphis," or green peach aphis, *Myzus persicæ* Sulz. Often one or both of these species might be found feeding on the same plant with the turnip louse, sometimes the colonies of the two species would over-lap. Both of these species have been confused with the turnip louse, even by entomologists. The cabbage louse was most often found on cabbage, but in the spring of 1915 it was common in the flower heads of mustard and turnip. From the observations made in this study it could be said that the turnip louse is most generally

found on turnips and radish, whereas the cabbage louse is usually found on cabbage. The cabbage louse seemed to be more hardy than the turnip louse. The garden aphis was found abundant on turnip and radish at all times. This species was very closely associated with the turnip louse. It was much more hardy and consequently bears very interesting biological relationships. The garden aphis proved to have a far greater adaptive capacity and so it could withstand far more unfavorable climatic conditions. In times when the turnip louse was absent from the fields this species served as a host for the natural factors of control. The parasites would not work on the garden aphis until the turnip louse was very scarce, but in this way the parasites could maintain themselves in numbers until the turnip lice might appear again. The garden aphis seemed to be free from the attacks of the predaceous enemies as long as an ample supply of turnip lice was present. The most wonderful of the seemingly selective power was that of the fungous disease. This disease proved destructive to the turnip louse when the garden aphis flourished. It was only when the numbers of turnip lice were very reduced that the garden aphis died from the disease. The garden aphis did not seem to be affected as much by the low temperatures as did the turnip louse.

The natural factors of control, which were present to a greater or less extent over the state, exerted a very marked effect on the turnip louse. In some sections the turnip louse was held in check so effectively that it was not feared as a pest. Observations were made on two species of parasites, three species of coccinellids, two species of syrphid flies, one species of chrysopa, and a fungous disease.

The most widely distributed parasite was *Lysiphlebus testaceipes* Cress. This species was always found in numbers in the northern part of the state in those localities where the "green-bug" has been destructive. This parasite always proves very effective in the control of the "green-bug." The other parasite, *Diœretus rapœ* Curt., was present in great numbers at College Station, and to a limited extent in the southern sections of the state. From the observations made it is evident that the life-history and habits of these lice parasites are quite similar.

Some interesting results were noted of the effect of temperature on the development and activities of *Diœretus*. The last week of December 1913 was very cold but the first week of January 1914 was quite mild. On January 9, adult *Diœretus* were taken in the outdoor cages. This brood continued to emerge for a period of over one week. On January 17, dead parasitized lice were again observed in the outdoor cages. During these first seventeen days of January the average

daily mean temperature was 50° F. Evidently this temperature does not prevent the development or activities of the parasite. From the dead lice which were collected on January 17, adult parasites emerged sixteen days later, or on February 2. The average daily mean temperature during this period was 59° F. On the night of February 6, the unusual temperature of 17° F. occurred. Lice which died on February 2 and were exposed to this cold were collected. Fifteen days after the lice died and eleven days after the freeze, parasites emerged from these lice. During this period the average daily mean temperature was 49° F.

The parasites were present only in limited numbers during the period from September 1914 to May 1915. During this time the importance of predaceous enemies was strikingly demonstrated. In four widely separated sections of the state the turnip louse was held in check by coccinellids. The presence of the predaceous enemies was much more constant over the state than the presence of the parasites.

The coccinellids were found to be always present where the turnip lice occurred. Three species were found over the state. They are *Hippodamia convergens* Guer., *Megilla maculata* DeG., and *Coccinella munda* Say. The first two named species were about equally abundant and the last was present only in limited numbers. In some sections of the state the spotted lady-beetle was called the "cold weather" lady-beetle. Our observations seemed to bear out the general statement that *H. convergens* is the more active and abundant in the fall and spring and *M. maculata* is the more active and abundant during the winter.

The syrphid flies were widely distributed over the state. At College Station they were quite numerous at times. *Syrphus americanus* Wied. was found generally distributed over the state. In the southern part of the state the oblique syrphid, *Allograpta obliqua* Say, was often found. In the spring of 1915 this species was also taken at College Station.

The chrysopa fly was usually found in all fields where the turnip louse was abundant.

The fungous disease is a factor of natural control which was very interesting on account of its sudden appearance and its effectiveness in eradicating the turnip louse. The fungus which was observed was undoubtedly *Empusa* sp., probably *Empusa aphidius*, though four species of this genus have been reported from Aphids.

This fungus was first noticed in the fall of 1913 on November 12. At this time many dead lice were found; some were orange in color and soft while others were brown and dry. These lice were mostly pupæ, though there were some immature apterous, and a few winged

lice. In just a week after the disease was first observed fully 30 per cent of the lice on the plants were dead from it. At this time most of the dead lice were immature apterous, and only a few pupæ and some winged lice. By the end of another week the lice were almost entirely destroyed by the fungus.

In the outdoor cages on January 7, 1914, the lice were found to be dying rapidly from the fungus. The previous week had been mild, though the last week in December 1913 had been very cold. The dead lice at this time were mostly apterous and only a few winged lice. By the end of a week the fungus had killed practically every louse in the outdoor cages. The average daily mean temperature during January 7 to 14 was 51° F. The fungus was again found in the outdoor cages on February 10. This was just four days after the low temperature of 17° F. The fungus was prevalent in the outdoor cages next on March 10. Two weeks later most of the lice had died. On March 30 the disease was widespread in the louse-infested fields.

Extensive experiments, extending over a period of two years, were conducted on the artificial control of the turnip louse. It was found that spraying was effective when properly done with a good material. The soap solutions gave very satisfactory results. For the reason that the whale-oil soaps are not generally available in Texas, laundry soap is recommended. The secret of efficient application is in the use of an extension rod, a 60° elbow, and an "angle" type nozzle.

President Glenn W. Herrick: I would like to ask Mr. Paddock if the turnip louse has the same pubescence as the cabbage aphis.

Mr. F. B. Paddock: The first distinguishing point between the two species is that the turnip louse is bare and the cabbage louse is covered with pubescence.

President Glenn W. Herrick: We will now listen to a paper by Mr. William Moore.

FUMIGATION OF ANIMALS TO DESTROY THEIR EXTERNAL PARASITES

By William Moore, *Assistant Professor of Entomology, University of Minn.*

Introduction

During the past summer, a number of experiments were undertaken at the Minnesota Experiment Station in a search for new insecticides. The first work was with a number of essential oils in the hope that some of these might prove valuable repellents to insects. It was

found, however, that most of the essential oils would injure plants when applied to them and when put on animals, the relief obtained from even the best was dependent upon the abundance and the hunger of the attacking insects. Several oils are valuable against mosquitos, but if in a locality where mosquitos are extremely abundant and very hungry, the results are not so good.

Toxicity of Nitrobenzene

The next group of compounds to be studied was the benzene series and the compound selected for the first week was nitrobenzene. It was found that one drop of nitrobenzene placed on a piece of filter paper and allowed to evaporate under a bell-jar containing approximately one cubic foot of air, would destroy the adult white fly on a plant in about one hour to one and a half hours. In looking through the literature to ascertain the toxicity of nitrobenzene, it was found that nitrobenzene is considered to be a very serious poison. Blyth[1] mentions a number of experiments showing that nitrobenzene is extremely poisonous. One experiment cited was that in which a cat was exposed under a glass shade in which 15 grams of nitrobenzene were evaporated on warm sand. The animal immediately showed symptoms of poisoning. After thirty minutes' exposure, when the shade was removed to introduce another 15 grams, the cat for a moment escaped, but was recaptured and replaced under the shade and in one hour and forty minutes was dead. He also cites the case of a man who died from the effects of nitrobenzene which had been spilt upon his clothes, to show that the vapor of nitrobenzene is poisonous. Filehne[2] cites a case in which he placed a rabbit in a large glass bottle into which he led strong nitrobenzene vapor. In a half-hour, the animal was no longer normal in appearance and in forty minutes was lying upon its side. He states that if the animal is then removed, in from a half-hour to two hours, it will return to its normal condition. If, however, it is not removed, the animal will die. Haines[3] states that nitrobenzene is poisonous when taken internally, when inhaled as a vapor, or when absorbed by the skin. He even stated that symptoms of poisoning may result from the use of almond glycerine soap, which contains nitrobenzene, particularly when used in hot water. Holland[4] states that nitrobenzene breaks down the blood corpuscles forming methemoglobin and paralyzes the nerve centers, the immediate symp-

[1] Blyth, Poisons and Their Effects and Detection, third ed., p. 184.

[2] Filehne, Ueber die Giftwirkungen des Nitrobenzol Archiv für Experimentelle Pathologie and Pharmakologie, Vol. 9, 1878, p. 342.

[3] Peterson & Haines, Textbook of Legal Medicine and Toxicology, p. 606.

[4] Holland, Medical Chemistry and Toxicology, 1915, p. 438.

toms, not being noticed for a few hours, are vividness of the face, bluish nails, feeble pulse, cold skin, giddiness, vomiting, and coma, sometimes complicated by convulsions, and finally death. If death is not prompt, jaundice may ensue. He states that symptoms similar to that of hydrocyanic acid poisoning has been induced by inhaling vapor in the industries where nitrobenzene is used. In order to ascertain exactly how poisonous nitrobenzene would be to animals, a large white rat was placed in a fumigation box of about six cubic feet and a drop of nitrobenzene to each cubic foot evaporated therein, the rat being exposed for a period of one hour. No symptoms of poisoning were noticed at the time the rat was removed nor later. Another rat was fumigated for three hours at the same rate without disastrous results. The dose was increased to four, then 24 and finally 40 drops per cubic foot for the same time without injury to the animal. It was then found that more nitrobenzene was used than could be contained in the air, the surplus condensing on the sides of the box. It was discovered that about two to three drops of nitrobenzene would saturate a cubic foot of air, making allowance for some to be absorbed by the wood of the sides and bottom. The next question was to determine how long the rat could live in the saturated air. A rat was placed in a larger fumigation box containing about 180 cubic feet. Sufficient nitrobenzene was evaporated to saturate the atmosphere and food was placed in the box. The rat was alive and active at the end of 24 hours, when he was noticed eating the food in the box. At 36 hours, the rat was alive but somewhat sluggish and at the end of 48 hours, he died. The experiment is not conclusive as the rat was forced to eat food which probably contained nitrobenzene. Also the lack of oxygen may have affected the results.

Fumigation with Nitrobenzene

The question immediately arose—If nitrobenzene is no more poisonous than here cited to higher animals, but is poisonous to the insects, why not fumigate the animals to kill their parasites? It was found that if a dog was placed in a fumigation box and sufficient nitrobenzene introduced to saturate the atmosphere, the fleas would leave the dog in about a half-hour and would be quite dead at the end of an hour and a half. A dog thus treated showed no signs whatever of injury. Experiments were conducted with hogs infested with lice and it was found that a longer exposure was necessary to kill the lice, six to eight hours being necessary to completely free the hog of lice. In this case, also, most of the insects left the animal before dying. No effects of poisoning were discovered. A cross-bred sheep with a very thick dense wool was next tried. An exposure of twelve hours removed about 90 per

cent of the ticks from the wool, but when picked up and kept in a vial, they revived in about twelve to twenty-four hours. Those left in the wool did not revive. Even though the ticks might not be killed with this exposure, by removing them to the floor of the box, one could easily destroy them later, by spraying the floor with some strong sheep dip. This is of particular value as sheep in wool cannot be successfully dipped. The fumigation did not kill the puparia. Chickens were fumigated and it was shown that, in eight to ten hours, all the lice on the chicken could be destroyed. In a chicken house which was fumigated the red mites were also killed. The mite causing scaly leg of chickens can also be destroyed by a ten-hour fumigation. The Texas cattle fever tick cannot be obtained in Minnesota on the animals, but specimens received from the South and fumigated in glass vials were killed by a ten-hour exposure. Most of the specimens of ticks were fully engorged females laying or about ready to lay their eggs. One case of interest was that of a female which had started laying, probably having laid a quarter of her usual number at the time of fumigation. The tick was killed by the fumigation and no further eggs were laid. It might be noted that the engorged female ready to lay or laying, is probably the most difficult to destroy.

The Effect of Nitrobenzene on the Animal

So far as could be noticed, the animals showed no signs of poisoning under normal conditions. They all fed readily when removed from the box, and when compared with normal animals, were indistinguishable. A dog fumigated for six hours was normal in heart beat, respiration, and temperature. A count of the red blood corpuscles of a guinea pig before fumigation and after fumigation showed little change. Five million four hundred thousand red corpuscles per cu. mm. were obtained before fumigation. After fumigation for 12 hours and a half the blood count obtained showed 6,040,000. Twenty-four hours later showed 6,320,000. In 48 hours, 5,840,000. Such slight differences might well be obtained by experimental error in the count. In order to determine whether nitrobenzene would have any injurious effect upon the animal when repeated a number of times, guinea pigs were obtained and divided into two groups, a fumigated set and a normal set. Each set contained one full-grown male, one young male, one full-grown pregnant female, and a litter of young, the mother of which was not fumigated. The one set was fumigated over night, the exposure varying from 12 to 13 hours and repeated each week.

When the pregnant female in the fumigated set gave birth to her young, they were fumigated along with the mother animal. The old males remained normal, varying slightly from week to week. The

old male in the normal set increased somewhat in weight, apparently not being quite full-grown. This was not true of the old male in the fumigation set, but this was not due to the fumigation, as he had been in my possession for six weeks previous and had not gained. The

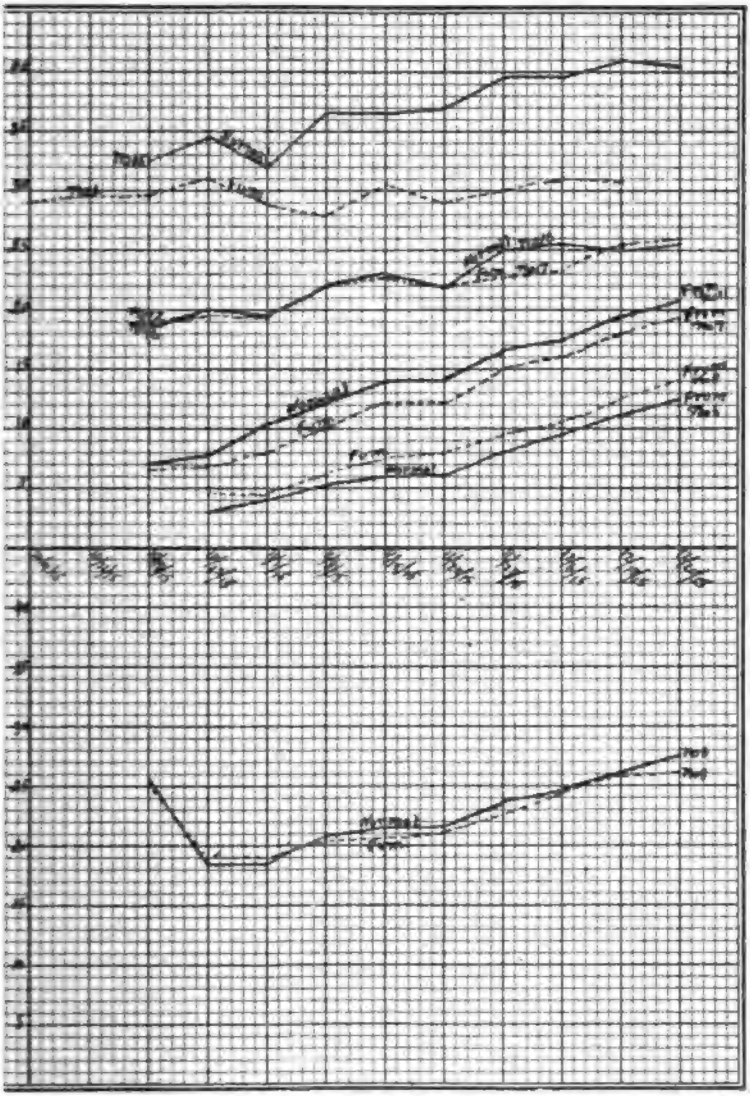


Fig. 5. Curve of growth of fumigated guinea pigs. No. 1 a male and nos. 16 and 17 young males. Average weights of litters of young from nos. 6, 7, 8 and 11. Nos. 6 and 8, females, were pregnant at the beginning and end of the experiment.

young males increased slightly in weight with practically no difference. The young gained regularly in both sets and no difference was shown between the young fed by a normal animal and the young fed by a fumigated animal. The female guinea pigs were perfectly normal. There was no abortion, although nitrobenzene has been used to produce abortion. These animals have now been fumigated for nine continuous weeks and the two sets are indistinguishable. One large male was fumigated for ten weeks and was then killed and his tissues examined. So far as could be noticed, macroscopically, there was no injury, but microscopically a very slight congestion was noticed in some of the slides of the lung, but not sufficient to affect the animal. It was noticed that chickens which had been fumigated rétained the odor of nitrobenzene in their bodies for several days after fumigation. Fumigated chickens lose this odor in five to seven days after fumigation. A short-horn cow was obtained and fumigated over night. The milk was tested by a number of people, some of whom noticed no difference between the milk of the fumigated animal and normal milk while others detected a very slight trace which, however, they agreed would have passed unnoticed under normal conditions. Milk will take up nitrobenzene if the cow is milked in the same room in which the cow had been fumigated. The milking 24 hours after fumigation showed no trace of nitrobenzene.

Some animals seemed to be more susceptible to nitrobenzene than others. An exposure of ten to twelve hours in a saturated atmosphere of nitrobenzene would produce the death of a cat while guinea pigs, sheep, etc., are not injured by a similar dose. It is, however, a well known fact that cats are particularly susceptible to coal tar derivatives. This does not detract from the value of nitrobenzene in destroying fleas on cats, as they easily stand a fumigation of one and a half hours. The nitrobenzene is taken into the lungs and hence to the blood from which it is probably removed by means of the kidneys. Herbivorous animals which urinate frequently seem to be less affected. The author and another person remained in a small room while it was fumigated with nitrobenzene for one and a half hours, destroying the house flies in the room. A slight irritation to the eyes and throat and a sweetish taste at the back of the mouth were the only symptoms noticed and no after-effects were discovered.

The Influence of Temperature

Professor Derby, of the University of Minnesota, Department of Physical Chemistry, worked out the amount of nitrobenzene which would saturate an atmosphere at different temperatures. From the curve, it is seen that at 83° F. about one drop is contained in a cubic

foot, while at 40° F. only about one-tenth of a drop will be held by a cubic foot of air.

Probably most of the results cited in the early portion of the paper, on the poisoning properties of nitrobenzene, were due to what might be termed super-saturated atmosphere in which the nitrobenzene was condensed as tiny particles in the air. In all of our later experiments, the nitrobenzene was allowed to evaporate from a cloth and not evapo-

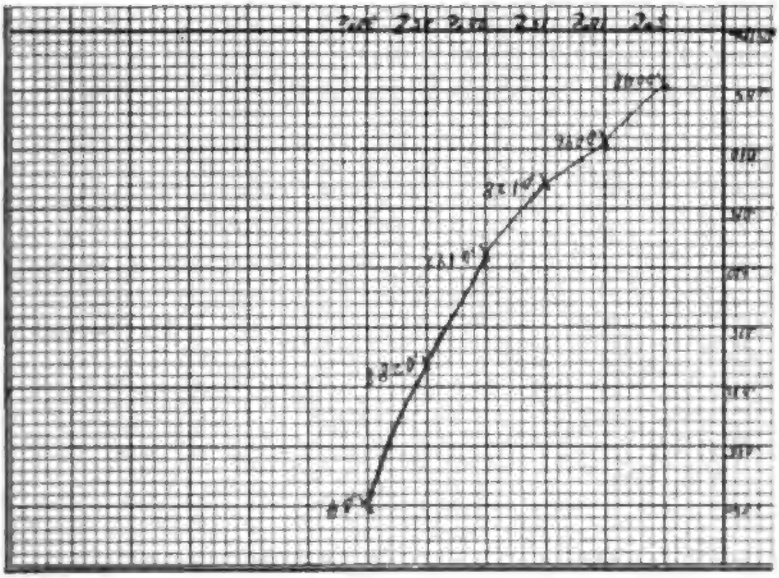


Fig. 6. Curve showing amount of nitrobenzene in grams to saturate an atmosphere at various degrees centigrade.

.13695	drops of $C_6 H_5 NO_2$ at	40° F.	per cu. ft.
.262944	" " " " " "	50° F.	" " "
.350592	" " " " " "	59° F.	" " "
.47808	" " " " " "	68° F.	" " "
.778832	" " " " " "	77° F.	" " "
1.0956	" " " " " "	86° F.	" " "

rated by heat. In the experiments cited from other authors, in most cases, the vapor of nitrobenzene was used, heat being applied to obtain it, and under such conditions probably as much as a drop would be contained in a cubic inch rather than a cubic foot. Although one can successfully fumigate chickens by an exposure of ten to twelve hours, by evaporating the nitrobenzene from a damp cloth, the same exposure to a super-saturated atmosphere obtained by evaporating the nitrobenzene by heat will kill the chickens, producing paralysis. The

difference between the results of other workers and my own apparently is dependent upon the method used.

Other Benzene Derivatives Giving Similar Results

After having obtained results with nitrobenzene, Mr. Marcovitch, working with me, tried out a number of similar compounds. Paradichlorobenzene will kill the fleas on a dog in about two and one half hours. Paradichlorobenzene seems to be less poisonous than nitrobenzene and one cannot obtain as good results in destroying the sheep tick as with nitrobenzene. Ortho, meta, and para cresol were tried but only the ortho cresol was successful. This compound will destroy the fleas in one and one half hours without injury to the animal. Carbolic acid crystals evaporated by heat will produce similar results in one and one half hours, while salicylic aldehyde, which is ortho hydroxyl benzaldehyde, will drive the fleas off the animal in five to ten minutes, but at the end of one and one half hours, the fleas will show signs of life, although they die in a few hours. A number of other similar compounds were tried without success.

The price of the chemicals varies considerably. Under normal conditions, nitrobenzene is about 20 cents per lb.; paradichlorobenzene, 25 to 30 cents per lb.; carbolic acid, 25 to 30 cents per lb.; salicylic aldehyde, 70 cents per oz.; ortho cresol, *about $1.00* a pound.

Conclusion

The above experiments open a new field in economic entomology. Considerable work is needed to determine why the poison will destroy an insect without injuring the animal. Experiments on a large scale, such as the fumigation of barns, must be conducted. The chief difficulty in Minnesota is the low temperature of the barns in the winter, which prevents sufficient nitrobenzene being held in the air to produce the desired results. As many entomologists, particularly those in the southern states, have better opportunities to study these chemicals under different conditions and on different insects, it is hoped that others will undertake experiments along this line.

From Division of Economic Zoölogy,
Minnesota Experiment Station,
St. Paul, Minn.

President Glenn W. Herrick: Is there any discussion of this paper?

Mr. E. P. Felt: I would like to ask if nitrobenzene is explosive.

Mr. William Moore: It is not. With the dose used it would be possible to have an oil stove in the same room. (Phial of nitrobenzene passed around for inspection.)

Mr. W. A. Riley: I should like to inquire whether the docility of the cat when taken from the box was due to its being under the influence of the chemical? What effect does it have upon a dog?

Mr. William Moore: It may have a more or less quieting effect upon the animal. The cat is more sensitive to the nitrobenzene than the dog, while the lack of oxygen in so small a box probably had an influence.

Mr. W. A. Riley: It is a paper of exceedingly great value in that the compound may be applied under ordinary conditions. I wondered if it was a question of applied psychology that as the paper started out with the details of the poisonous effect of the chemical, attention was focused on possible dangers of its use.

President Glenn W. Herrick: I have been very much interested in the paper. We have been doing some work at Cornell on the use of paradichlorobenzene for some subterranean insects. Mr. Hawley, a graduate student, has been working along these lines with the white grub. I have been intensely interested in this project.

I should like to ask, have you arrived at any idea concerning the quantity one should use?

Mr. William Moore: Under ordinary conditions probably two or five drops will be sufficient to saturate 1 cubic foot of air and make allowance for absorption by the wood. By saturating a cloth with nitrobenzene and tacking it in the box it will saturate the air sufficiently for effective treatment, during the night.

Mr. W. C. O'Kane: What is the effect on plants?

Mr. William Moore: In greenhouse fumigation it is not effective. You can saturate the air and kill the insects but it injures the plants. I might say that we are getting results with paradichlorobenzene. We have fumigated grain without injuring germination, in fact some grain so treated germinated more rapidly.

Mr. W. C. O'Kane: What are the results on insect eggs?

Mr. William Moore: I do not think it will destroy them.

Mr. George A. Dean: In your discussion you spoke of the nitrobenzene as hastening the germination of the seeds. I should like to know whether you have carried on any experiments or have any data as to the repellent properties of nitrobenzene. The reason that I ask this is because in Kansas, where we are carrying on experiments for the control of the kafir ant, we are trying to find some substance, with which the seed can be treated, that will act as a repellent and not injure the germination. I might say that we have found that one

of the methods of control for the kafir ant is to handle the ground in such a manner as to hasten the germination of the seed, and since, as you have stated, the nitrobenzene seems to accelerate the germination, I was thinking that, if it would also act as a repellent, it would be an excellent thing with which to treat the kafir seed.

Mr. William Moore: It acts somewhat as a repellent to insects as insects leave the animal when fumigated.

Mr. George A. Dean: Does the seed retain the odor for any length of time?

Mr. William Moore: For quite a long time. Seed treated by fumigation with nitrobenzene will retain a certain amount of the chemical but this will not injure the germination if the grain is in the soil. When a germinator is used the young shoots will be injured by the nitrobenzene which has evaporated into the air of the germinator.

President Glenn W. Herrick: We will next listen to a paper by Mr. H. A. Gossard.

THE CLOVER LEAF-TYER (ANCYLIS ANGULIFASCIANA ZELLER)

By H. A. Gossard

In early April, 1905, my attention was attracted to the ragged, eaten condition of the clover leaves on the Station farm. A great army of small, leaf-tying caterpillars were found to be responsible for the damage. The injury rivaled that inflicted at the same season by the clover leaf weevil, *Phytonomus punctatus*. A little later a swarm of small tortricid moths appeared in the field, the chrysalid shells being numerously exposed in the trash and among the leaves where the caterpillars had fed. Investigation failed to discover any like degree of damage being inflicted elsewhere, so the insect was not specially followed up at the time, but was kept under observation through several succeeding seasons. I have not since seen it do so much damage as in 1905, but every year it is a somewhat inconspicuous inhabitant of Ohio clover fields, doing more damage than one is likely to suspect.

Dr. C. H. Fernald confirmed a lucky guess I made as to its identity, after he had compared my specimens with three of the original specimens from which Zeller wrote his description, these having been given to Dr. Fernald by Zeller. With the exception of a brief note by Dr. Fernald on the species, in Psyche, V. 3, and a similar note by the same writer in Trans. Am. Ent. Soc., V. X, there is no literature relating to it, except Zeller's description of the adult published in the Verhandlungen der k.-k. Zoölogisch botanischen Gessellschafft, Vol. XXV, 1875, and a few bibliographical references.

Food Plants and Character of Damage

The known food plants are the common red, alsike and white clovers. From laboratory tests I conclude that alfalfa is scarcely or not at all eaten.

Clover foliage eaten by the caterpillars presents a ragged appearance, the epidermis from one of the surfaces being either partially or wholly eaten away, while the epidermal cover remaining appears thin, papery and white, except for minute splotches and streaks of green here and there, which, through chance, were left uneaten. Either the upper or lower surface will be eaten, whichever happens to be turned inward in the cell in which each caterpillar ensconces itself. When newly hatched, the young caterpillar chooses some natural or accidental depression or crease in the leaf surface, such as overlies the midrib, and ties the opposing surfaces together by a fine, whitish expansion of silk, this with the leaf-walls forming a hollow tube within which the caterpillar hides and feeds; or, very often, two leaflets, one of which overlies the other, will be tied together with silk and the caterpillar will feed between them. Such leaflets may be on the same or on different petioles. As the caterpillars grow older they show a tendency to construct cells of considerable size, usually three-sided, each side consisting of a leaflet. When full grown the caterpillars make a thin, white cocoon of silk within their cells, and pupate.

Life-History

There are three broods per season. The first brood of moths appear in late April and early May and are nearly all gone by May 20, stragglers holding on till mid-June. The eggs are laid on the leaflets, hatch in two or three weeks, and the caterpillars come from about June 1 to June 20. The pupal period lasts from seven to fourteen days and the second brood of moths range from about July 1 to July 20. The second brood of caterpillars are at work from about July 20 to August 15. The second brood of pupæ come from about August 15 to September 20. The last brood of larvæ feed from the middle of September until some time in November, when they spin about themselves light, white, silken cocoons like so many of their family relatives, and thus spend the winter, possibly feeding a little in mild weather. They feed voraciously in early April, must pupate about the middle of that month, and issue in late April and May as the first brood of moths.

Remedies

From this life-history it is apparent that the first clover harvest will carry to the mow most of the larvæ and pupæ of the first brood,

and that the second cutting will take off many of the second brood. Fall pasturage will destroy many of the third brood. The present well-established customs for harvesting and pasturing clover furnish a logical and effective program of control.

President Glenn W. Herrick: The next paper is by Mr. J. S. Houser.

DASYNEURA ULMEA FELT—A NEW ELM PEST

By J. S. Houser

Reference to this insect in entomological literature has been made but three times previous to the present. In 1907 and 1911, Dr. Felt merely referred to it and in 1913 he described the adult form. In the latter article, immediately preceding the technical description, Dr. Felt states:

> This dark brown species was reared May 7, 1888, from aborted elm buds evidently taken in the vicinity of Washington, D. C., presumably by Mr. Pergande. Apparently the same gall was collected at Jamaica Plain, Mass., by J. G. Jack.

So far as the writer has been able to determine, the above constitutes the complete recorded distribution of the insect to date. It was found first in Ohio, September 21, 1914, infesting an elm used as a street tree, Oakland Ave., Dayton, O.; later in 1914 and in 1915 it was observed in a number of places in Cincinnati, O.; July 25, 1915, a small elm was observed at New Matamoras on the Ohio River; and July 27, 1915, an additional small elm, at Mineral, O., was observed to be infested. Adults bred April 28, 1915, from Dayton material, were sent to Dr. Felt who very kindly identified them. Adults have not been bred from galls taken at other places, identification having been based upon the very characteristic gall only. It may be of interest to note in passing that the writer has been able to secure adults only when infested twigs were collected just at the time the foliage was starting to expand. It seems it is true with this, as with some other members of the family having similar habits, that the expanding of the foliage is essential to the emergence of the adults.

The injury inflicted by the species is the formation of from one to twenty aborted bud galls, usually at the twig tips, resulting in the checking of branch development, and ultimately in the stunting and malformation of the tree. In some of the most severe cases observed, 70 per cent or more of the branches were affected; in other instances

the infestation was but slight. A curious, and thus far unexplained, feature of the problem is that the pest exhibits a preference for individual trees, wherein a given specimen may be rather severely attacked, while nearby neighbors of the same species are but slightly, if at all infested. Thus far, white elm, *Ulmus americana*, only has been observed to be injured.

As previously stated, the adult has been described by Dr. Felt. The egg and pupal stages have not been observed by the writer, but larvæ may be found in abundance in the galls of infested trees from midsummer until spring. Usually more than one larva occurs within a single gall, in some instances as many as eight having been found. In two cases larvæ of different sizes, some very small and some apparently two-thirds grown, were found within the same gall. Where more larvæ than one occur, they are not separated from one another by the gall tissue but lie in a mass in the center of the gall. There is probably but one brood per season. The individual larvæ are pink or flesh in color, 3.5 mm. long and 1 mm. broad. They are typically Cecidomyid and possess the "breast bone" like organ and ability to spring into the air characteristic of many of the larvæ of this family.

Fig. 7. *Dasyneura ulmea;* typical galls slightly enlarged.

Parasitism is quite common, the adult parasites emerging through circular holes cut through the walls of the upper half of the gall. Only one species has been reared, determined by Mr. S. A. Rohwer, of the Bureau of Entomology, as *Callimome* sp. The parasites seem to be in no wise as sensitive to the drying up of the galls as do the midges,

since adults have emerged from dry material kept in the laboratory several weeks.

The future status of the insect as a pest of course cannot be forecasted, but it would seem reasonable to suppose that, on account of its apparent rather general distribution throughout southern Ohio, the creature has been present in the state for some years. This, considered in connection with the fact that heavy parasitism sometimes occurs, would tend to discourage placing it in the category of elm pests of prime importance. Nevertheless, it cannot be ignored, since individual trees are sometimes considerably stunted.

Concerning control measures, the one which seems most practicable is the cutting away of all twigs bearing aborted bud clusters before the foliage starts in the spring. As noted previously, the writer has been successful in rearing adults, only when material was collected at the time the foliage was expanding, and that the parasites emerged from material that had been cut some time. It would seem, therefore, to be the best policy to cut the twigs and leave them lie on the ground in order to allow the parasites a chance to emerge.

President Glenn W. Herrick: The next paper will be presented by Mr. T. J. Headlee.

SULPHUR-ARSENICAL DUSTS AGAINST THE STRAWBERRY WEEVIL (ANTHONOMUS SIGNATUS SAY)

By Thomas J. Headlee, Ph.D., *Entomologist of the New Jersey Agricultural Experiment Station*

The strawberry weevil appears first to have been recognized as an injurious insect by Glover[1] in 1871 from damage done to the strawberry in Maryland. He suggested sweeping the plants with a muslin net as a means of controlling the insect. Cook[2] in 1883 suggested the use of London Purple (1 lb. to 200 gals. of water) or of crude carbolic acid and land plaster (1 lb. of acid to 50 lbs. of plaster). Riley[3] in 1885 suggested trial of kerosene emulsion and of pyrethrum mixed either with flour or water. Beckwith[4] in 1892 added white hellebore to the preceding recommendations and discounted the use of arsenicals. Chittenden, having mastered the main points in the life of the insect, summarized previous work of control and added a statement of

[1] Glover, T., Rept. U. S. Commissioner of Agric. for 1871, p. 73.

[2] Cook, A. J., 13th Rept. Sec'y. State Hort. Soc. Mich. for 1883, pp. 151–155.

[3] Riley, C. V., Rept. of U. S. Commissioner of Agric. for 1885, pp. 276–282.

[4] Beckwith, M. H., Bul. 18, Del. Agric. Expt. Station, 1892.

his own conclusions. His work is recorded in several papers, the final summary of which was presented in 1897 in Cir. 21, 2d Ser., Div. of Ent., U. S. Dept. Agric. He points out that relief may be had by: (1) Covering the beds with muslin or other similar material, (2) Cultivation of pistillate or of profusely blooming varieties, (3) The use of trap crops and clean culture. He suggests a trial of Bordeaux mixture as a repellent; the trial of Paris green and arsenate of lead, alone and combined with Bordeaux. Chittenden particularly recommends the practice of growing pistillate varieties, asserting that it has been thoroughly tested and found to be successful. Little, if any, progress in measures of control seems to have been made since the publication of Cir. 21.

For the sake of appreciating the nature of this problem of control, we should remember: that the damage is due primarily to the oviposition habits of the adult; that it consists mainly in puncturing the unopened staminate buds, laying an egg therein, and cutting the bud stalk almost off at a point some distance below the bud; that the attack begins just as the early buds begin to open and continues for a period of about two weeks; that the insect can and does use the wild strawberry, blackberry, dewberry, black-capped raspberry, common yellow flowered cinquefoil (*Potentilla canadensis*), and the red-bud tree (*Cercis canadensis*) and frequents wild flowers generally for feeding purposes.

Covering the beds with muslin or other similar material has not proven a practical measure for the larger growers. The cultivation of pistillate varieties has not proven acceptable owing to the alleged inferiority of the fruit. The cultivating of profusely blooming varieties has not proven acceptable. The use of trap crops has not met with favor because all the labor incident to them will in many years be in vain owing to a natural reduction of the beetle. Clean culture fails to meet with favor for much the same reason. The use of arsenicals and Bordeaux mixture have not yet met with success. Chittenden lists a host of so-called remedies as useless—lime, ashes, plaster, Paris green and plaster, hen manure, a mixture of tobacco dust, lime, Paris green and coal oil, pyrethrum, whale oil soap, kerosene emulsion and sweeping with an insect net.

In view of the wide range of food plants used by the strawberry weevil, any effort to prevent its work by direct destruction through clean culture and trap crops would seem doomed to failure except in districts free from woodlands and undeveloped or waste lands. If this is true, the problem of control is narrowed to one of rendering the plants distasteful or deadly during the two weeks when the damage is normally done.

Accordingly the writer in coöperation with Mr. Elwood Douglas,[1] County Agent for Atlantic County, New Jersey, set out to test various repellents and deadly substances by keeping certain plots covered with them throughout the period of danger.

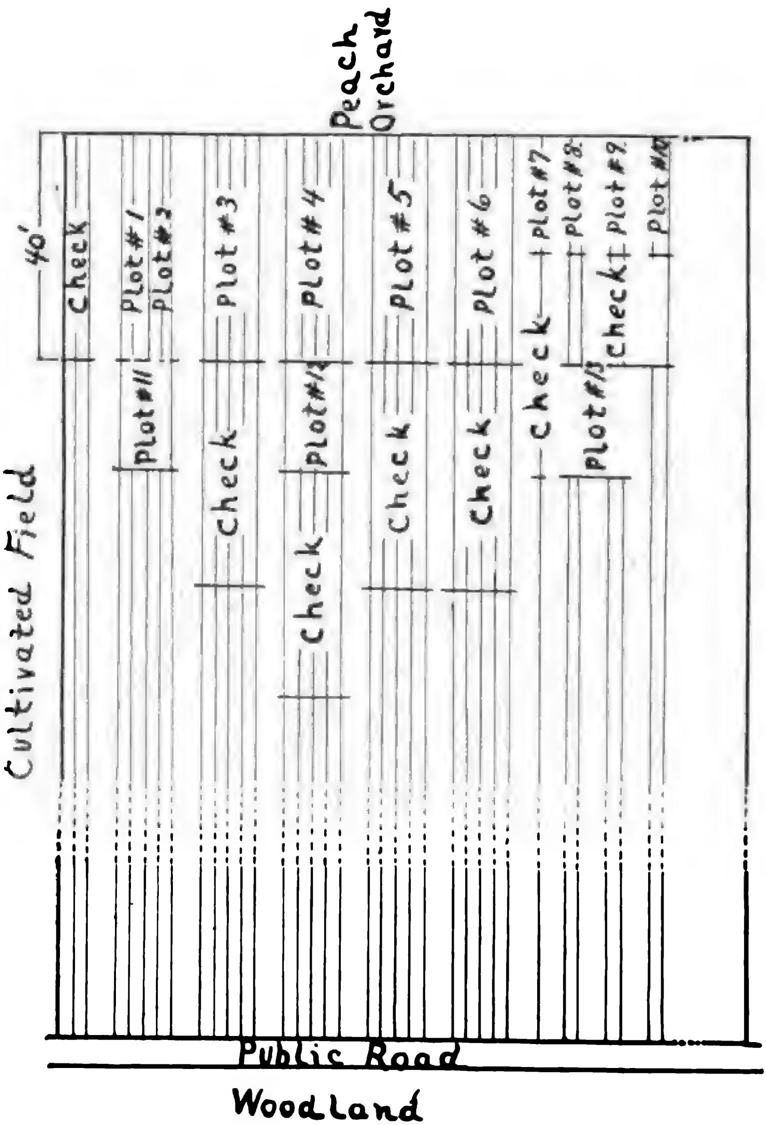


Fig. 8. Diagram of experimental plots

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[1]Mr. Douglas secured the place for work, helped to make the application and to keep a record of the results.

The tests were made on a variety ("Heritage") growing on a sandy farm near Cologne, New Jersey. Woodlands of mixed pine and oak were located on the southern and western side of the field and that part farthest from them—the southeast corner—was chosen. None of the plots exceeded one eighth of a mile from the woodlands. The infestation was rather even with a noticeable increase in numbers of beetles as the woodland to the south was approached.

We resolved to try contact insecticides, stomach poisons and pure repellents. The contacts chosen were pyrethrum, whale oil soap, tobacco dust, and 40 per cent nicotine. The stomach poisons were arsenate of lead both as a powder and as a spray, a dust of arsenate of lead (1 lb.) and sulphur (1 lb.), a dust of arsenate of lead (1 lb.) and sulphur (5 lbs.), and arsenite of zinc. The pure repellents were Bordeaux mixture (5–5–50) and hydrated lime.

The arrangement of the treatments with relation to the field, each other, and the checks is shown in the preceding diagram. The treatment began when about 6 per cent of the buds had been cut—a little later than we intended. If the determinations of the buds cut showed little or no protection or that the mixture had burned the plants it was not repeated. The table which follows shows the details.

TABLE OF TREATMENTS AND RESULTS

Plot No.	Treatment		Percentage of Buds Cut		Effect on Plants
	Nature	Dates of	May 5, 1915	May 14, 1915	
	Check at beginning nothing		20	48	
1	Whale oil soap and water, 1 oz. to 1 gal.	April 30	6	52	Scorched slightly
2	Whale oil soap (10 oz.), pyrethrum (1 lb.) and water (10 gals.)	April 27	6	42	Scorched slightly
3	Arsenate of lead (3 lbs.) and water (50 gals.)	April 28	10	25	None
4	Arsenate of lead (1 lb.) and sulphur (1 lb.) dust	April 30, May 6	7	8	None
5	Arsenate of lead (1 lb.) and sulphur (5 lbs.) dust	April 28, May 6	6	12	None
6	Home-mixed Bordeaux (5–5–50)	April 28	20	49	None
7	Tobacco dust	April 30	12	51	None
8	Powdered arsenate of lead	April 29, May 6	7	19	None
9	Powdered arsenite of zinc	April 30	Badly burned		Burned badly
10	Hydrated lime	April 30, May 6	7	41	None
11	Whale oil soap (500 ozs.), Blackleaf 40 (1 gal.) and water (500 gals.)	April 30	6	42	Scorched slightly
12	Dry pyrethrum	April 30	11	41	None
13	Pyrethrum (1 lb.), whale oil soap (10 ozs.) and water (10 gals.)	April 30	14	53	Scorched slightly
	Check at end nothing		38	60	

Limited application of the two mixtures of arsenate of lead and sulphur made on May 18, when the strawberries were in full bloom, did not apparently injure the open blossoms.

It thus appears that the powdered arsenate of lead and sulphur give the best protection—in fact, almost perfect protection. The plots treated with the arsenate of lead and sulphur when in full bloom were almost as white as snow while the untreated plots were green with here and there an occasional blossom.

The second treatments were applied when much bloom was out but none of the substances used the second time seemed to blast the blossoms.

Later in the season, a study of the cost of treating with a mixture of powdered arsenate of lead and sulphur was undertaken.

A plot 10 rds. long by 2 rds. wide was selected, containing 8 two-feet-wide rows of strawberries running lengthwise. Care was taken to coat the plots to about the same extent as had proven successful in the experiments and the half and half sulphur-lead mixture was used.

Nine and three quarters lbs. of material were used in covering this plot and 6.56 minutes were required to go over the area. At this rate the amount of material per acre is 78 lbs. and the amount of time is 52 minutes and 28 seconds. On the basis of 10 cts. a lb., which is probably the lowest figure the half and half mixture could be had for, the cost of material for the two treatments that have proven necessary would be $15.60 an acre. On the basis of the 1 to 5 mixture the cost would be about $7.30. For the sake of easy figuring let us assume that the time required for each application is one hour. The cost of labor would not exceed 40 cts. an acre.

Thus we see that the total cost for materials and labor ranges from $7.70 to $16.00 an acre. In view of the fact that, owing to heavier foliage, the amount of material used was greater than that necessary in the spring and the additional fact that practice would enable the operator to cover his territory more rapidly, it is probable that the actual cost of the application will prove much less than the figures given would lead one to expect.

President Glenn W. Herrick: Is there any discussion of this paper on the strawberry weevil?

Mr. William Moore: I was rather interested in Dr. Headlee's paper. We have been working on the strawberry weevil in Minnesota, but have obtained some opposite results. I was speaking to Dr. Headlee about this and he states that in New Jersey the weevil hibernates in woods. In Minnesota we get the weevil coming back to

the berry patch in the fall of the year or late summer and at that time they feed on the leaves of the plants.

I would like to ask Dr. Headlee a question. Did the sulphur and arsenic act as a repellent?

MR. T. J. HEADLEE: Purely as a repellent. Very few cases of destroying the weevils.

MR. WILLIAM MOORE: We find that the weevils do not feed in the spring.

PRESIDENT GLENN W. HERRICK: We will now listen to a paper by Mr. C. L. Metcalf.

THE EFFECT OF CONTACT INSECTICIDES ON THE LARVÆ OF SYRPHIDÆ

By C. L. METCALF, *Columbus, Ohio*

(Withdrawn for publication elsewhere)

PRESIDENT GLENN W. HERRICK: I am interested in the use and effect of black-leaf 40 because it is widely used in New York State for controlling aphis on apple.

SECRETARY A. F. BURGESS: I would like to ask in regard to the method of spraying in your experiment.

MR. C. L. METCALF: The tests, except one, were laboratory tests in which a small part of the twig was cut off and this twig and the aphids and larvæ present, after being sprayed with the solution, were placed in a cheese-cloth covered glass jar.

In the last experiment a section of a limb of a sycamore tree about three feet long was isolated with a band of tree tanglefoot at each end so the larva could not escape and the insecticide applied in the field.

SECRETARY A. F. BURGESS: Have these experiments been checked in the field to determine the effect of the different solutions you used? The solutions you used were no doubt weak. The contact solutions that are being used in the field at the present time have to be strong. The sample can be sprayed with a weak solution but when it comes to field applications it is more difficult to do effective work with weak solutions.

MR. C. L. METCALF: The black-leaf 40 was used at the strength recommended for destroying ordinarily resistant plant lice. In the other cases the question to be determined is whether in the long run it will be more satisfactory to use a stronger solution, thus killing aphids and larvæ; or a weaker solution which would allow the larvæ to remain and destroy any aphids not covered, and so not killed by the insecticide.

President Glenn W. Herrick: I should like to ask what species of aphis were used.

Mr. C. L. Metcalf: The two species used were *Aphis spireacola* common on Spirea in Maine and *Longistigma caryæ* which is very common here in the lower branches of the sycamore.

President Glenn W. Herrick: I want to ask you how they would compare in resistance with the green apple aphis.

Mr. C. L. Metcalf: The *Aphis spireacola* would be just about the same, *Longistigma caryæ* more resistant than the apple aphis.

President Glenn W. Herrick: The last paper on the program will be given by Mr. W. C. O'Kane.

ARSENIC ON FRUIT AND FORAGE FOLLOWING SPRAYING

By W. C. O'Kane, *Durham, N. H.*

(Withdrawn for publication elsewhere)

President Glenn W. Herrick: In answering inquiries in regard to orchard spraying I usually state that it is best to keep cattle out of the orchard after spraying until heavy rain has fallen.

Secretary A. F. Burgess: I am particularly interested in these experiments because the question of injuring animals as a result of spraying often comes to our attention. In spraying work throughout the country districts that are infested with the gipsy moth, we adopt the policy of spraying where the owner agrees not to pasture his stock after the spray has been applied. In many cases this is perhaps an unnecessary precaution but it is done simply to prevent controversy or misunderstanding. These experiments, I believe, are the first definite and extensive ones that have been carried through on this particular subject and the information will be of great value to entomologists.

Mr. James Troop: I want to add a bit of experience from Indiana. A number of years ago I carried on some experiments along this line in the orchard at Purdue University. The orchard was in blue grass, and the trees about twenty years old, so that the tops nearly covered the ground. During the spraying season, the superintendent of the farm insisted on letting the sheep run in the orchard. I sprayed this orchard thoroughly for three years with arsenate of lead, using as high as 3 pounds to 50 gallons of water. These trees were sprayed at three different times, each season, and the work was so thoroughly done that the grass under the trees was quite wet. The sheep fed all over this ground, but no harm to the sheep was ever noticed.

SECRETARY A. F. BURGESS: We use arsenate of lead at a strength which is greater than ordinarily used for orchard spraying, hence there might be more danger in the applications of the spray which we use. Early in the season 10 pounds to 100 gallons of water are used and the amount later is increased to 12½ pounds and occasionally to 15 pounds if the gipsy moth caterpillars are very large and it is necessary to kill them quickly. Emphasis should be placed on the necessity of keeping the spray mixture thoroughly agitated. We have encountered considerable difficulty in having the arsenate of lead properly mixed with water before it is placed in the tank. Mr. Worthley has just devised a churn which can be used to thoroughly mix the material. This is a matter which should be given attention if thorough spraying is to be done.

MR. W. C. O'KANE: Regarding arsenic left on fruit after spraying with arsenate of lead, I think I am safe in saying that you never see on apples in the market enough poison to cause the death of anyone.

Adjournment 12.00 m.

AFTERNOON SESSION

Tuesday, December 28, 1915, 1.30 p. m.

PRESIDENT GLENN W. HERRICK: The first paper on the program will be given by Mr. W. H. Goodwin.

THE CONTROL OF THE GRAPE BERRY WORM (POLYCHROSIS VITEANA CLEM.)

By W. H. GOODWIN, *Wooster, Ohio*

The grape-berry moth has been known in Ohio through its injuries for nearly fifty years. A number of entomologists have contributed to a knowledge of its life-history and habits: among them are Walsh, Riley, Slingerland, Johnson and Hammar. Several others have been engaged, at various times, in economic measures for berry moth control, but were only partially successful. Experimental work for berry worm control was carried on in 1906 to 1909 by Professor Gossard and assistants, but was finally discontinued on account of the disappearance of the serious infestation of the previous seasons.

Beginning with the seasonal life-history, the winter is passed in the pupal stage. The larva spins a silken cocoon in the fall inside a fold or flap cut out of a grape leaf. These leaves are usually flat on the ground, or they have only one edge buried in the soil, but they are always soft and moist. This seems to be the proper condition of the leaf to make it an attractive place where the larva can spin up for the

winter. These tiny pupal cases lay on the ground all winter, normally, but they break loose from the body of the leaf and are often washed some distance from the place where they spun up, by the melting of the snow and by heavy rains with a large run off of surface water. Records of several such occurrences have come to my notice and on two occasions in particular, several vineyards were practically freed from berry worm for a season by being overflowed and having all the leaves and cocoons washed away. A few of the pupæ are killed through falling into crevices in the soil of the vineyard and being buried so deeply they cannot get out again. Many of these pupæ are killed by severe freezing weather when the soil is dry and is not covered with snow. The mortality is low, however, when we have snow and wet weather throughout the winter. The extreme variations of an open winter together with dry soil may be largely responsible for the high rate of mortality. A large per cent of the specimens kept in breeding jars with moist or wet soil emerged in the fore part of June for three successive years, while others, kept under the same conditions, excepting that the soil was extremely dry, failed to emerge or the brood was represented by only 18 to 50 individuals when over 400 pupæ had been placed in the breeding cage in the preceding October.

In the latter part of the first week in June to as late as the 25th day of June in some seasons, the tiny pupæ begin to get active and wriggle or swing the rear segments back and forth. Two rows of small sharp spines on each of the abdominal segments from the second to the eighth inclusive, and one row on the ninth segment, catch in the sides of the silken wall of the cocoon and push the pupæ out of the cocoon if the struggling is continued. The front row of spines on each of these segments are larger in size, fewer in number, and do not extend more than one-third of the way around the dorsal side of the pupa, while the rows of smaller, shorter spines extend approximately half way around each of the eight segments. The swinging of the abdominal segments back and forth, sideways, and with a spiral or rotary motion makes these rows of spines catch, and every move pushes the pupa out of the cocoon. The operation takes only a few minutes' time until the pupa is about half-way out of the silken cocoon, or in case they are buried only a slight distance below the surface, they struggle until the thoracic segments of the pupa project above the surface of the soil. The pupal skin splits along the back to the first abdominal segment and the moth works out of the pupal skin, leaving almost half of the empty skin projecting out of the cocoon. The wings expand and harden in 15 minutes to half an hour, but the moth will often remain on some stick or dead leaf for several hours before it attempts to fly. If they are left undisturbed, they will sometimes remain in one place

from 8.00 or 9.00 a. m. to 2.30 or 4.00 p. m. before flying to some other position. However, they are usually able to fly in about twenty minutes after emerging. The moths seldom fly until late in the afternoon, usually becoming active about 2.30 to 4.00 p. m., and when confined in the breeding cages make frantic efforts to escape about this time of the day. When not confined, they fly to the under side of some vine or deeply shaded section of a vineyard, usually settling on the canes, where they are very inconspicuous on account of their similarity of coloration. In fact, it is only after a careful search that one can find them at all. Seemingly selecting the deep shade, the females lay most of their eggs in those portions of the vineyard where the foliage is very dense, especially when the berry worm infestation is not heavy, and the ground slopes toward the level sections having the heavy growth. Those parts of vineyards where the soil is seriously depleted and the yield of grapes is approaching a minimum, are seldom injured much by the berry worm. In many vineyards where poorly nourished, dwarfed vines carry only a small amount of foliage they are scarcely injured at all. Some vineyards, with areas of strong and weak vines, are scarcely infested on the light areas while severely injured by the berry worm on the strong, vigorous vined areas.

In northern Ohio the moths seldom emerge in numbers before the 8th to the 12th of June, varying with the season. Sometimes part of the brood emerges a few days earlier or later, but the main part of the brood usually appears from the middle to just a few days after the close of the blooming time of the standard varieties of grapes. In confinement, the moths laid some eggs from four to seven days after they emerged. A few individuals were tardy in emerging and others were equally tardy in oviposition. This makes it difficult to give exact dates for spraying, and the variation of blooming time of the grapes through seasonal variations complicates matters still more. Individuals of this brood of moths often live for ten to seventeen days, giving a long period of time for oviposition and making the application of a single poisonous spray of little apparent value. Poisons, adhering to the rapidly growing grape berries, are soon decomposed and also cover a relatively small part of the berries after ten days' time.

The larva of the grape berry worm usually feeds on the pulp of the berries. In June, a partially grown larva has often webbed together half of a developing cluster of grapes and devoured the small berries and stems, living inside of the protecting web. These webs were plentiful in some vineyards by the 25th of June and many of the larvæ were almost full grown. Large numbers of these larvæ were collected, but did not emerge as moths until the first week in August. The

larvæ are very active and often wriggle out of the grape bunch in their attempts to escape, spinning down on a silken thread unless they are violently disturbed. In the vineyard, these larvæ always spin up on the young and tender leaves of the growing grape cane. The older leaves seem to be too thick and harsh and in some way unsuitable for the forming of a cocoon near their edges. The cocoon is usually made on the edge of the thin, soft, rapidly growing leaf. In a few days the growth of the leaf will tear the tissue along the edge of the cocoon, and a few of these cocoons fall to the ground, but the larger part hang to the grape leaf by a mere shred of leaf tissue. The late individuals of this first brood of larvæ cause the rapidly growing grape berries to split open when the small larva destroys the pulp cells just below the skin of the berry. The tissue above, being cut off from a supply of nourishment, cannot grow or expand. The remainder of the berry continues to grow and the berry bursts open; sometimes it gets red on the edges of the break. The larvæ of the August brood rarely cause any bursting open of the berries. The grape berries are growing more slowly at this time and the purple spot on the side of the berry is the first visible sign of injury.

The opalescent eggs of the berry moth hatch in five to eight days and the larvæ develop rapidly in the young clusters of growing berries. Usually the earlier individuals web part of a bunch of berries together and often destroy almost half of the small cluster of grapes. Berry worms of this brood brought to Wooster from Euclid and Dover, Ohio, transformed to pupæ about the 20th to 30th of July in 1913 and 1914, but did not transform until the 1st to 7th of August in 1915. Larvæ collected from around Wooster, fifty miles further south than Euclid or Dover, transformed into pupæ almost a week earlier and the moths appeared from the 27th of July to the 2d of August in both 1913 and 1914. The main part of the brood of moths from the region of Lake Erie did not appear until the 5th to the 10th of August in 1913 and 1914, but were much later in 1915, the bulk of the brood coming August 11 to 17. In 1908, the moths of this brood were bred from material brought from East Cleveland and the greater part of them emerged during the latter part of July, ranging from the 29th to the 4th of August. From a scanty amount of Wooster material collected in July, 1909, moths appeared July 26 to 29, only a small number of moths emerging from the breeding material. The moths, emerging in the fore part of August, commence laying eggs in 3 to 5 days and continue to deposit their semi-transparent, slightly oval eggs for about 7 to 11 days. The eggs are normally glued to the sides of the berries, but they are often placed at the base of the berry stem just

where it swells in size, very close to the berry. If the brood of moths is large, eggs may be found on almost every berry. At Venice, O., in August 1915, as many as 62 eggs were found on a single bunch of 47 Catawba grape berries. One section of the vineyard averaged almost an egg to every berry on the vines. A large series of bunches were examined and the number of eggs and berries were counted. Sprayed sections of the same vineyard averaged a little less than one small worm to the bunch of grapes. In 1913, similar conditions were found at East Cleveland, and eggs were very plentiful in a number of vineyards, especially on the Catawbas. Many eggs were found in 1915 which turned dark and failed to hatch. They were readily broken, but did not seem to be parasitized, rather appearing to be infertile or else attacked by disease.

In the latter part of August and the first few days of September, small larvæ can be found in abundance, but I have been unable to find any full grown or almost mature larvæ at this time. These larvæ develop rapidly through the last week in August and the month of September. As the berries begin to ripen, the juices within the wormy berries ferment, and the berry worm larva seeks an adjoining berry, webbing the berries together as it attacks them. The juice of the abandoned berries ferments and evaporates so that a large part of those in unsprayed vineyards are only empty shells by picking time. The berries look all right from a distance of 10 or 12 feet, but close inspection reveals the fact that what ought to be grapes are nearly all mummies with only the form of the grape berries. Each full grown worm in early October averages from 4 to 9 berries which it has injured or rendered worthless.

Control Experiments

A large series of experiments for the control of the grape berry worm were performed by Prof. H. A. Gossard and J. S. Houser at Kelley's Island in 1907. The author made the larger part of the final counts and completed the season's experimental work. Various poisons and stickers or spreaders with fungicides were used on plots large enough to demonstrate their practical value. Paris green, arsenite of soda, and arsenate of lead were used in combination with Bordeaux mixture; iron sulfate mixture, with resin soap, laundry soap, and arsenate of of lead was used alone. The poisons were used at varying rates and with single and double treatments, using the fixed spars on the traction spraying machine. Spraying, directing the nozzles by hand, was also tried and compared with machine spraying. The following tables indicate the results of the various treatments.

Poison	Fungicide and Sticker	No. of Sprays	How Applied	Per cent Wormy
Paris green	Bordeaux and soap	2	Single machine	26.5
Arsenite of soda	Bordeaux and soap	2	Single machine	26
Arsenate of lead	Bordeaux and soap	2	Single machine	20.4
Paris green	Bordeaux and soap	2	Double machine	10.8
Arsenite of soda	Bordeaux and soap	2	Double machine	11.6
Arsenate of lead	Bordeaux and soap	2	Double machine	4.8

Single machine sprayings failed to give results largely because enough spray did not reach and cling to the grape bunches to be effective. These sprayings were made about June 20 to 22 and July 8 to 12. The various spreaders and stickers used with 3 pounds of arsenate of lead paste gave results as follows:

		Per cent Wormy
	Bordeaux and iron sulfate	10.18
	Bordeaux only	8.57
	Bordeaux and soap	7.9
	Bordeaux and resin soap	4.47
Hand-sprayed,	Bordeaux and laundry soap	2.9
Unsprayed		58.3

The spray was applied at a pressure of 70 to 90 pounds and double sprayed with fixed spars, excepting the hand-sprayed plot.

In 1908 similar experiments were made by the author under Professor Gossard's direction, at Euclid, O. Comparing single and double machine-sprayed plots and hand-sprayed plots, some differences are shown:

	Per cent Wormy
Single machine sprayed	21.5
Double machine sprayed	10.4
Hand-sprayed (with soap)	.71
Double machine sprayed (with soap)	4.67
Unsprayed	47.00

Arsenate of lead 3 pounds to 50 gallons of 3–6–50 Bordeaux was used in these tests with 1 pound of dissolved laundry soap as a sticker and spreader where soap was added. The spray was applied with a traction machine at 60 to 90 pounds pressure. Straight spars with the nozzles pointing at right angles to the row of grape vines were used in the machine work.

In 1907 and 1908 the applications of spray were made just before the grapes bloomed, again about June 18 to 22, and the 10th to 15th of July, when three sprayings were given.

Control measures were at first devised with the idea of reducing the size of the early broods of worms, there being supposedly three broods, thus preventing the serious attack of the last brood in the season. The large quantities of poison used was dangerous and much doubt was expressed concerning the possible deleterious effects of spray still adhering at picking time. The life-history of the berry worm was incomplete, leaving the experimenter without definite ideas of the exact time to spray and with what to spray in order to control it. The striking result obtained by Professor Gossard at Kelley's in 1907 indicated that the date of spraying should be pushed as late as was consistent with safety, but its limit was undetermined. Life-history studies have shown, however, that in the 1907 experiments the third spraying of the season was made before the first brood larvæ were half grown and many larvæ had not been hatched for more than a week. The poisonous effect of this spraying would be of little value by the 3d to 10th of August as experiments of later years have shown.

In 1909 a small vineyard at Wooster at the Ohio Agricultural Experiment Station was sprayed with dilute lime-sulfur 1 gallon in 50, with 3 pounds of arsenate of lead, and compared with arsenate of lead 3 pounds, Bordeaux 3–6–50, and 1 pound of soap. The lime sulfur practically defoliated the section treated and also destroyed the set of grapes. These were the only important results of 1909.

The grape berry worm control work was discontinued for several years on account of the difficulty in getting satisfactory coöperators, and also the partial disappearance of the berry worm.

In the fall of 1912 grape growers in the East Cleveland district appealed to the Ohio Agricultural Experiment Station for help, as the berry worm had almost destroyed their crop. A similar appeal came from the west of Cleveland District in 1913.

In 1913 experimental work for the control of the grape berry worm was begun in the vineyard of Dr. C. C. Arms at Euclid, O. The spring was cold and the grapes were slow in starting. Experimental work was based on previous experience and on the work of Johnson and Hammar at North East, Pa., given in Bulletin 116, Part II, Bureau of Entomology, U. S. D. A., and a program planned accordingly. Life-history studies had been started the fall previous as control measures depended largely on knowing the habits of *P. viteana* in northern Ohio.

The set of bunches before bloom was light, promising only a small crop of grapes for 1913. Plots were selected and a spraying made before the grapes bloomed. The plots selected were located on almost level land and each plot consisted of about two-thirds of an acre of grapes. The larger part of this section was Concords, but the plots

included some Catawbas, Delawares and a few Niagaras. A series of different sprays were used, applying the poison at different strengths, using it without and with Bordeaux (3–4–50 and 4–4–50) and also without soap, with soap, and with Bordeaux and soap in order to compare the effectiveness of the poison in different combinations. The various plots were sprayed just before the grapes bloomed June 9 to 12, just after the grapes bloomed June 18 to 21, and again on July 18 to 21. No moths had appeared at the latter date, but it was thought best not to digress too radically from previous experimental work in which good results were obtained. In the hand-sprayed plots the first and second sprayings were omitted to test the value of one thorough spraying later in the season.

The bulk of the brood of moths coming almost three weeks after the third spraying, together with the final results showing serious injury by the grape berry worm throughout the vineyard, seemed to indicate that the final spraying must be made some two or three weeks later than had been previously recommended.

The spray was applied with a power machine of large capacity and at 200 pounds pressure. The spars were of the fixed type, but the nozzles were not pointed at right angles to the grape row. The nozzles were placed comparatively low down and were angled so that the spray was thrown upward and outward as well as forward and backward, meeting the roof of the leaves edgewise instead of throwing the spray against the roof-like protecting surface of the leaves. The special spars were designed by the author, in order to completely cover the bunches of grapes with spray in a thorough manner, approaching, if possible, the best hand-spraying in covering capacity without extra labor. The ability to cover a considerable area of vineyard rapidly with a minimum expense for labor was also an important item, as directing the spray nozzles by hand adds to the cost of spraying grapes. These spars with the nozzles angled outward and upward saved the labor cost of the two men required to direct the nozzles in hand spraying. Paste arsenate of lead was used in varying amounts and in combinations with Bordeaux and soap. The results are given below with data concerning the treatment of the plots:

PLOTS AT EUCLID—1913

First Application, June 9 to 12

	Poison	Fungicide	Sticker
Plot 1	As. of Lead 3#	2–3–50 Bord.	Hard Soap 1#
" 2	" " " 3#	3–4–50 "	
" 3	" " " 4#	4–4–50 "	" " 1#
" 4	" " " 3#		" " 1#
" 5	" " " 3#	3–4–50 "	Flour in Paste 4#
" 6	" " " 3#	3–4–50 "	Hard Soap 1#

Second Application, June 18 to 21

	Poison	Fungicide	Sticker
Plot 1	As. of Lead 3#	2-3-50 Bord.	Hard Soap 1#
" 2	" " " 3#	3-4-50 "	
" 3	" " " 4#	4-4-50 "	" " 1#
" 4	" " " 3#		" " 1#
" 5	" " " 3#	3-4-50 "	Flour in Paste 4#
" 6	" " " 3#	3-4-50 "	Hard Soap 1#

Third Application, July 15 to 18

	Poison	Fungicide	Sticker	Counts Sept. 10, 11 Wormy
Plot 1	As. of Lead 4#	2-3-50 Bord.	Hard Soap 1#	26.7 %
" 2	" " " 4#	3-4-50 "		33.1 %
" 3	" " " 6#	4-4-50 "	" " 1#	19.4%
" 4	" " " 4#		" " 1#	45.7%
" 5	" " " 3#	3-3-50 "	Flour in Paste 4#	26.4%
" 6	" " " 4#	3-4-50 "	Hard Soap 1#	24.4%
			Unsprayed	84.0%

Paste Arsenate of Lead used in 1913.

In the 1913 tests, arsenate of lead was used alone, with Bordeaux, 2-3-50, 3-4-50, arsenate of lead with soap, and with Bordeaux and soap, with flour paste and Bordeaux, and a few vines were sprayed in July with arsenate of lead and gelatine for a sticker and spreader.

Arsenate of lead with Bordeaux, 2-3-50, and 1 pound of soap gave as good results as any of the other stickers and spreaders used, and was not as difficult to prepare, also it cost less than the other spreaders and stickers with the poison.

1914

The experimental work of 1914 for berry worm control was more extensive than on previous years as the members of the Dover Fruit Growers' Association coöperated with the Department of Entomology of the Ohio Agricultural Experimental Station in addition to the work at Euclid, O. In the plot work at Euclid, arsenate of lead was used at the rates of 2 pounds and 3 pounds of the dry or powdered material to each 50 gallons of spray. These amounts of poison were used with soft soap, with 2-3-50 Bordeaux, with iron sulfate Bordeaux, with Bordeaux and soft soap, and with cheap molasses as stickers or spreaders. Hand spraying was also tested in comparison with machine work. The results are listed below:

Plots at Euclid—1914

	June 8 to 10			June 24 to 27		
	Poison	Fungicide	Sticker	Poison	Fungicide	Sticker
1	As. of Lead 2#	2-3-50 Bord.	Soap 2#	2#	2-3-50 Bord.	Soap 2#
2	" " " 2#		" 2#	2#		" 2#
3	" " " 2#	2-3-50 "	(1½ gal. Molasses)	2#	2-3-50 "	(1½ gal. Molasses)
4	" " " 2#	(Bord. 2×4×50 with 4 of Iron Sulfate)	Soap 2#	2#	(Bord. 2×4×50 with 4 of Iron Sulfate)	Soap 2#
5	" " " 2#	2-3-50 Bord.	" 2#	2#	2-3-50 Bord.	" 2#
6	" Hand Sprayed	"	" "	"	"	" "
6a	" "			"	"	" "
6b	" "			"	"	

	Poison	Fungicide	Sticker	Wormy
1	As. of Lead 3#	(Nicotine Sulfate 1-1000)	2# Soap	2.14%
2	" " " 3#		2# "	7.10%
3	" " " 3#		(1½ gal. Molasses)	10.40%
4	" " " 3#	Nicotine 1-800	2# Soap	4.49%
5	" " " 3#	2-3-50 Bord.	2# "	1.98%
6	" " " 3#	"	" "	.86%
6a	" " " 3#	"	" "	2.10%
6b	" " " 3#	"	" "	1.43%
		Unsprayed		33.20%
		Neighboring Unsprayed		54.00%

Soft soap was used as it cost about half as much as hard soap.

In the various plots, arsenate of lead as the poison gave a wide range of results with the different stickers or spreaders and fungicides. Arsenate and soap and arsenate and molasses gave the highest percentages of wormy grapes of any of the sprayed plots. In plots 1, 5 and 6, very similar results were obtained but plot 6b with only one thorough spraying in the latter part of July had only 1.43% of wormy berries. In the Dover region similar results were obtained when instructions were followed and the sprayings were carefully done.

Dover Experiments—1914

	Sprayed about June 8 to 11	Sprayed about June 22 to 26	Sprayed about July 30 to Aug. 5	
Vineyard	As. of Lead 3# Paste Bordeaux 2–3–50 Soap (soft) 2#	As. of Lead 4# Paste Bordeaux 2–3–50 Soap (soft) 2#	As. of Lead (In one case, Bordeaux 2–3–50) Syrup 1½ gal.	Per cent Wormy
*1	"	" " "	(July 23 to 30 Hand-sprayed in some sections)	3 to 7 %
*2	"	" " "	July 23 to 30	2 to 5 %
*3	"			1 to 4 %
4	"		Hand-sprayed	1 to 2.5%
5		July 8 to 15		8 to 11%
6		" 8 to 15		
7			July 22 to 31	3 to 22%
8		(No worms present)	Unsprayed	0
9			July 23 to 30	6 to 10%
10			Unsprayed	3 to 11%
11			(Sprayed about July 10)	14 to 37%
	Unsprayed			31 to 68%

* Sprayed with power machines.

In the Dover experiments each coöperator did all of the spraying in his vineyards, the author only giving directions when to make the applications and what to use.

The sprayings were made with whatever type of machine the coöperator could afford to purchase or the machine he already owned.

In some cases the applications were made at times when they were of little value, and others used inadequate and inefficient machines. The results show the value of proper spraying, as some of the coöperators who obtained the best results had the worst infestations of berry worm to fight.

Some striking results were often side by side, among them being the extremes of worminess in the berry worm control work; from full foliage to no foliage on Delawares on September 23 where the 2–3–50 Bordeaux held downy mildew in check, while arsenate of lead alone did not do so, and the fruit on the defoliated section did not ripen well. A few examples of spraying with 4–4–50 Bordeaux were found and the stunted cane growth and reduced amount of foliage were very notice-

able, especially where this strength of Bordeaux was used before and after bloom with arsenate of lead and soap.

The results obtained in 1913 and 1914 left little doubt that the spray before bloom and the one following 5 to 8 days after blooming were not of as much value as the August spraying in controlling the berry worm. In 1915 the spraying before bloom was omitted entirely except in a few badly infested vineyards. Some of the best results obtained were in vineyards which received only one thorough spraying in August with 3 pounds powdered arsenate of lead in combination with 2-3-50 Bordeaux and 2 pounds of soft soap.

EUCLID EXPERIMENTS—1915

Plot	June 29 to July 2			Aug. 4 to 7			Sept. 20
No.	As. of Lead	Sticker	Bordeaux	As. of Lead	Sticker	Bordeaux	Wormy
1	6# Paste	Soap Soft 2#	2-3-50	6# Paste	Soap 2#	2-3-50	8.6%
2	6# "	" " 2#		6# "	" 2#		14.2%
3				3# Dry	" 2#		17.4%
4				4# "	" 2#	2-3-50	9. %
5	2# Dry	" " 2#	2-3-50	4# "	" 2#	2-3-50	10.6%
6	2# "	" " 2#	2-3-50	2# "	" 2#	2-3-50	17.7%
7	2# "	" " 2#	2-3-50	2# "	No Soap	2-3-50	30. %
	Check Plot Unsprayed No. 1						81.2%
	" " " " 2						97.3%
	Averaged Unsprayed						89.2%

DOVER EXPERIMENTS—1915

	June 20 to July 9			July 26 to Aug. 13			
No.	As. of Lead	Sticker	Bordeaux	As. of Lead	Sticker	Bordeaux	Wormy
1	4# Paste	Soap 2#	2-3-50	(Same spray in latter part of July on one section)			27% 14%
2	4# "	" 2#	2-3-50				15%
	Unsprayed Aver. No. 2						74%
				Aug. 11 to 13			
3	4# Paste	Soap 2#	2-3-50	(6# Paste	Soap 2#	2-3-50)	11%
				Aug. 4 to 7			
4	4# "	" 2#	2-3-50	(6# Paste	Soap 2#	2-3-50)	8%
5	4# "	" 2#	2-3-50				57%
6	4# "	" 2#	2-3-50				54%
7							
8	No record						37%
9	No definite records of spraying work						67%
10	Unsprayed						82%

E. L. Steuks, Sandusky, O., 1915

Sprayed August 8 to 12

As. of lead 3# Corona Dry Bordeaux 2-3-50 Soft Soap 2#

Counts October 7, 1915

Hand-sprayed August 8 to 12

Wordens 3% wormy Catawbas 2% wormy Concords 3.5% wormy

Hand-sprayed August 15 to 17

Concords 9% wormy Catawbas 10% wormy

Unsprayed

Concords 77% wormy Wordens 46% wormy Catawbas 89% wormy

The experiments for the control of the grape berry worm in 1915 were more extensive than in the years just preceding. The work was conducted in several different grape growing districts in northern Ohio in order to ascertain the practical value of the previous experimental work. Wherever the coöperators followed instructions and made the heavy application of spray carefully and thoroughly, good results were obtained, averaging less than 15 per cent wormy in the face of heavy infestations, ranging from 28 to 97 per cent wormy in unsprayed vineyards. The various coöperators who sprayed at other times, not following instructions, only confirmed the striking results obtained by spraying at the proper times. A large number of such instances have been carefully observed, although not all of the spraying was done by coöperators in the berry worm control work.

The studies of the life-history and control of the grape berry worm have included a large amount of experimental work. The moist leaves lying on the ground and upon which the berry worm spun up in the fall were gathered and destroyed on a fairly large acreage, resulting in a material reduction of the berry moth the next summer. The owner found he could pick over from one to three acres per day depending upon the condition of the vineyard.

Plowing in the latter part of May, covering those pupæ still in the vineyard, seemed to reduce the numbers of moth in June but was only partially effective.

Spraying throughout the season has been tested in comparison with one, two and three sprayings. Varying amounts of poison were used with molasses, iron sulfate and lime, soap gelatin, flour paste, nicotine sulfate and different strengths of Bordeaux mixture as spreaders or stickers and for fungus disease control. The arsenate of lead, soap, Bordeaux combination has proved the most practical, the cost and labor of preparation being less and the results obtained indicate it was more effective than other combinations.

Many kinds of sprayers and equipment were used. The power sprayers with narrow trucks and 100-gallon tank making the ma-

chine not over 7 feet long exclusive of the tongue, were the most efficient and convenient machines. The spars with the nozzles throwing the spray upward and outward were very good for the June spraying when the foliage and cane growth was not extremely heavy and the spray would reach the grape bunches.

For the August spraying the trailer method, applying the spray by hand, is more effective and economical, as it is impossible to cover every grape bunch with spray with fixed spars at this season of the year. In 1914 the spar method proved almost as good as hand applications but the wood growth was not heavy. In 1915 the wood growth was extremely heavy and hand spraying was much better than when fixed spars were used.

Nozzles are very important accessories in grape spraying. The small-capacity, short-range nozzles are of little value. Nozzles having a carrying capacity or range of 8 to 12 feet at 200 pounds pressure permit the operator to reach every grape bunch without tangling his nozzles with the grape vines. A four-foot bamboo covered rod was more convenient to use than any other length. These were used on leads of hose 40 to 60 feet long.

The vulnerable spot in the life-history of the grape berry worm, to the author appeared to be at a time just preceding the depositing of the eggs upon the berries. The moths emerging in June rarely come in a short period of less than one week, although in 1914 the bulk of the brood came in 4 to 5 days. The August brood of moths comes with a rush, almost 90 per cent of the pupæ transforming to moths in 6 or 7 days. The egg-laying period is also not so extended. In 1915 large numbers of moths placed in cages with bunches of grapes sprayed with arsenate of lead died within 2 days, while those confined with unsprayed bunches lived from 4 to 11 days. This is worthy of further investigation, as it may only happen when the moths are in confinement. No eggs were deposited in the first mentioned cage, but in the latter eggs were plentiful. In the field the first eggs could be found on the 10th of August, 1914, but could not be found until the 14th of August in 1915. On August 15, 1915, they could be readily found at Sandusky, O. West of Cleveland a few unhatched eggs were found on the grapes on August 24, 1915, but they were not plentiful. A few unhatched eggs were found on the grapes at Sandusky during the first week of September.

In the control work the best results have been obtained by the heavy applications of 4 pounds to 6 pounds of arsenate of lead paste in 50 gallons of Bordeaux with 2 pounds of soft soap, the week following the blooming of the grapes when the largest berries are about one-eighth of an inch in diameter. The second application comes between six and

seven weeks later or approximately seven weeks after the grapes bloom. This late application of spray should be heavy and thorough, covering every bunch of grapes with spray, preferably by the trailer method. Normally, in northern Ohio this spraying comes between the 3d to 12th of August and may be the only one needed.

From 80 to 200 gallons of spray per acre have been used in the various experiments. For the June spraying 100 to 120 gallons per acre applied with spars was effective, but the August spraying requires about 160 gallons per acre applied by hand. The greater amount of poison, 6 pounds paste, should also be used in this spraying. The amount of poison adhering at picking time is undoubtedly small, although considerable spray may still be visible on the bunches. During the six to nine weeks between the time of the last application of spray and the time of picking, the poison is almost wholly oxidised or dissolved and no injurious effects will result from eating these grapes. The total weight of the crop of grapes well sprayed is from two to five times as much as from similar areas of unsprayed vineyards. Several instances of even greater differences in weight of the crop at harvest time have been observed, the most unusual being about 900 pounds from an unsprayed acre and 9,700 pounds from an acre of sprayed vineyard. One-third of a ton of Concord grapes or one-fourth of a ton of Catawbas will generally cover the cost of making two thorough applications of spray. Does it pay? Is it worth while?

President Glenn W. Herrick: I should like to ask, Mr. Goodwin, how many broods did you find?

Mr. W. H. Goodwin: Two broods.

President Glenn W. Herrick: These accord with Johnson and Hammar?

Mr. W. H. Goodwin: Yes sir, excepting that both broods of the moths emerge earlier by ten days and I have never had any erratic or out of season broods. The hatching of the first brood of berryworms, like the emergence of the moths, is distributed over a period of four or five weeks and the worms are only partially controlled by the spraying made five to nine days after the grapes bloom. In northern Ohio most of the first brood moths emerge from the 5th to 12th of August, 90 to 95 per cent of them appearing in seven to nine days. A thorough hand spraying at this time poisons most of the worms soon after they hatch. Thus one thorough spraying destroys practically all of the second brood worms. The former recommendations provided for three applications of spray by the middle of July and were too early

to effectively poison larvæ hatching a month after the last spraying was applied.

President Glenn W. Herrick: Have you found eggs of the moths appearing in the spring?

Mr. W. H. Goodwin: Yes.

President Glenn W. Herrick: Where are they usually laid?

Mr. W. H. Goodwin: On the stems of the young grape cluster. The late moths of this brood deposit them on the small berries.

Mr. W. C. O'Kane: One of the most interesting and valuable features of this paper is the way it illustrates and emphasizes the importance of timeliness and thoroughness in the application of a remedy. Mr. Goodwin has not used any different remedies from what have been used before, but his success is due to the way he has worked out the manner of application and the time of it.

President Glenn W. Herrick: Mr. J. L. King will now present his paper.

NOTES ON THE CONTROL OF THE LESSER PEACH TREE BORER

By J. L. King, *Cleveland, Ohio*

(Withdrawn for publication elsewhere)

President Glenn W. Herrick: Is there any discussion or questions to ask Mr. King?

I was interested in one point namely, that the paper emphasized the fact that a substance effective in one territory under certain climatic conditions is sometimes of no avail in a wider territory or different climatic conditions.

I would like to ask if the asphaltum used was of the same grade as that used in California?

Mr. J. L. King: Yes sir. We wrote to the California people and bought from the same firm.

I want to emphasize the fact that had I drawn my conclusions in the fall of the same season that the asphaltum was applied, the results would not have appeared so destructive but instead I allowed the trees to remain through the winter so as to get the effect of freezing. This seems to have brought out fully the injurious effect of the asphaltum upon the bark.

President Glenn W. Herrick: How was that applied? In continuous rings?

Mr. J. L. King: In some cases rings about the base of the trunk and in others over the wounded areas of the bark.

Mr. E. P. Felt: I would like to ask Mr. King if he saw any evidences of the inner bark being penetrated or discolored by the asphaltum?

Mr. J. L. King: Not until late in the season did I get discoloring of the bark. When removing the bark it seemed to be very green during the first part of the season.

Mr. E. P. Felt: How were the trees the spring of the next year?

Mr. J. L. King: In the following spring the bark was brown and dead under the areas which were covered with the asphaltum.

In most every case where it was applied at the base of the trees as a preventive against Sanninoidea, the trees died or were very severely injured.

President Glenn W. Herrick: We will now listen to a paper by Mr. E. P. Felt.

CLIMATE AND VARIATIONS IN THE HABITS OF THE CODLING MOTH

By E. P. Felt, *Albany, N. Y.*

Climatic differences appear to exert a considerable influence upon the habits and the type of injury caused by the codling moth if conditions obtaining in New York State the past two or three years are reliable criteria. Last summer 20 per cent or more of the crop in some orchards, and in others an even larger proportion bore the characteristic blemish we have termed "side injury." This is known among New York fruit-growers as "side worm" and by many of them is supposed to be the work of the second brood of the codling moth or that of some unknown insect. Dr. Quaintance informs us that this is the so-called "sting" of western fruit-growers.

The blemish, apparently first figured and described by John W. Lloyd in 1907 (Bul. 114, Ill. Agric. Expt. Sta.), has a diameter of about one-eighth of an inch and ordinarily may be found on the smoothest and most exposed face of the apple. There is a discoloration, sometimes reddish or reddish-brown, marked by a small central slit or puncture, the point where the young apple worm enters the fruit. This injury may be easily distinguished from small scab spots and certain types of hail damage, by the characteristics given above.

Observations the past season have shown that this type of injury, hitherto almost ignored, is due to the work of codling moth larvæ hatching from late-deposited eggs—that is those laid the latter part of June or early in July. At this time the fruit has attained considerable size, being an inch or so in diameter, is much smoother than the

small apple and relatively more conspicuous. The moths seem to display a marked partiality for such fruit, and from observations in the orchard we estimated that fully 75 per cent of the eggs laid at this time were deposited upon the apples. The late-hatching codling moth larvæ appear content in many instances to eat a small, shallow, circular gallery just under the skin of the apple and with a radius of about one-sixteenth of an inch. They may then, in large measure, desert the initial point of attack and migrate to the blossom end. We have repeatedly found empty side blemishes and then located the wanderer on the surface of the apple or even in the blossom end, and in the case of sprayed trees it is by no means uncommon to find a small, dead caterpillar at the bottom of the calyx cup. The impulse to desert an apparently satisfactory shelter and brave the dangers of migration to the blossom end can hardly be explained as other than hereditary and an outcome of the same unrest which, under other conditions, leads the larva to forsake the leaf mines and search for fruit. It is perhaps unnecessary to point out that while a small mine in a leaf may amount to very little, similar damage to the fruit means serious loss.

It is noteworthy, in studying conditions in various portions of New York State, that side injury was decidedly more prevalent in the western part, especially in the vicinity of Lake Ontario, and probably in other localities where a large body of water may prevent a marked rise of evening temperatures in the spring. There is on record a statement by Cordley to the effect that eggs are not deposited when the evening temperature falls much below 60° F. In this connection some interesting data have been published by Sanderson (N. H. Agric. Expt. Sta., 19th–20th Repts., 1908, p. 406). He found that if the evenings were cool, egg-laying would sometimes be deferred for several days and stated that from June 9 to 15, 1906, he was able to secure eggs, but after that the evenings were cool until the latter part of the month and no eggs were obtained until June 28. Again, in 1907, "no eggs were found until June 22 . . . . though moths had been emerging since the 10th." An examination of records made the past four years by Mr. L. F. Strickland, Nursery Inspector of the State Department of Agriculture, located in Niagara County, shows a fairly close connection between this type of injury and the rise of daily evening temperatures above 60° F., and on comparing this data with similar temperature records for inland points well removed from the influence of large bodies of water such as Wappinger Falls (near Poughkeepsie) and Chatham (near Albany) we find the records for these latter localities during the past few years to be such as to permit a fairly prompt deposition of eggs, assuming that such will

occur when evening temperatures are at 60° F. or higher. In the latter places there was comparatively little side injury. It should be stated in this connection that the daily minimum temperature is only an approximate guide, since, other things being equal, there is a greater drop in the temperature between evening and early morning inland than obtains in localities near large bodies of water. This will vary under different conditions and can only be approximated when minimum temperatures alone are available as happens to be the case in this instance. It is evident, from what we know of the crepuscular habits of the moth, that the evening temperatures are the controlling ones and here is an excellent opportunity to establish a series of records which may be of great practical value.

Every entomologist having personal experience in the control of the codling moth knows that ordinary applications of arsenical poisons can not be relied upon to destroy the young codling moth larvæ hatching from late-deposited eggs before they have injured the fruit to some extent. Consequently, in localities where these conditions obtain, thorough spraying results in almost no end wormy fruit and a comparatively small reduction in that showing the side blemish; in other words this side injury must be controlled to a considerable extent by the application of the preceding year, and here we have a very strong argument for thorough and systematic annual spraying whether the trees be fruiting or not.

President Glenn W. Herrick: The paper is particularly interesting to me as showing the desirability of careful observation of old insect pests and it shows what important things may turn up as a result of these observations.

Was there any side injury from the second brood?

Mr. E. P. Felt: I do not know. I am inclined to think that this serious "second brood" injury in western New York is due to late deposition of eggs.

I saw nothing that led me to believe that there was any great amount of side injury from this brood this year.

Mr. James Troop: I would like to ask if Dr. Felt saw where very many or any of this first brood continued to eat into the apple until they had reached the core. We have had a good deal of trouble with this insect in Indiana during the last few years, but have found that in most cases where the larvæ started in at the side, they continued to eat into the core of the apple. I examined a great number of wormy apples and found that over 50 per cent of the larvæ of this first brood went from the side, as the larvæ were still in the apples

when the examination was made. I have noticed shallow holes that were made in the apple by the larvæ, but in most cases the larvæ were found dead in the holes, showing that they had gotten some of the poison in eating through the skin.

Mr. G. D. Shafer: Did you find any dead larvæ in these side injuries?

Mr. E. P. Felt: No, I did not find any. I did not look closely for them.

President Glenn W. Herrick: Had the trees been sprayed?

Mr. E. P. Felt: Yes, they had been sprayed. Observations on habits of the larva hatching after late deposition of eggs was included in the experiment.

Mr. G. D. Shafer: Two years ago in Michigan I found a great many larvæ and in a few cases I was able to find dead larvæ in the little cups of the injury. I wondered if the larvæ had gotten some poison and thus succumbed to that.

Mr. E. P. Felt: Lloyd records killing larvæ in that way.

President Glenn W. Herrick: I will now call for a paper by Mr. S. W. Bilsing.

LIFE-HISTORY OF THE PECAN TWIG GIRDLER

By S. W. Bilsing, *College Station, Texas*

Introduction

Pecan growing has become an important industry in Texas and the means of controlling the insects which affect both the tree and the nut are of great importance.

In the autumn of 1913 several of the three-year-old pecan trees in the orchard of the Horticultural Department at College Station were severely damaged by the pecan twig girdler, *Oncideres texana*. Upon close examination it was found that the damage was caused by a single female. The damage was so great that it was decided to make an investigation of the life-history of this insect.

This insect was marked by putting a drop of red ink on the right wing cover, and the methods of oviposition and egg-laying habits were closely observed. During the fall of 1913 this one female entirely severed one young tree about two feet from the ground and pruned three other trees. Every limb was pruned on two of these trees and a third was pruned almost as severely. In all, 16 limbs were severed by this single female. In each case the limbs severed were from 8 to 10 mm. in diameter. Since then we have noted individuals which cut

off limbs more than an inch in diameter. The limbs, however, are usually 7 to 10 mm. in diameter.

Food Plants

This insect is not at all choice in the selection of a tree upon which it intends to girdle limbs.

Pecan, persimmon and the various species of elm seem to be preferred to the others. Pear trees are also often severely pruned. From the observations we have made it would appear that most any kind of a plant may be selected if necessity demands it. The following is a list of trees on which the insect has been taken: Pecan, persimmon, elm, hackberry, mesquite, rose, sweet locust, water oak, post oak, live oak, hickory, maple, pear, and peach.

Egg-Laying Habits

The limb is first cut off although this habit varies to some extent and occasionally some of the eggs are deposited before the limb is entirely severed. In nearly all cases the adult stands with head downward in cutting off the limb. After severing the limb the adult begins to oviposit. The eggs are laid at the base of the leaf buds and usually one egg is deposited at a place, but this also varies and sometimes two and in rare cases 3 or 4 eggs are deposited at one leaf bud. The number of eggs deposited in a single limb varies but is usually from 8 to 12. The female is usually accompanied by the male but the girdling is done entirely by the female. Before depositing the egg she makes an incision with the mandibles at the point where the egg is to be deposited. After this incision is made some little time is taken to hollow out a place between the bark and the limb in which to place the egg. This hollowing out process is done by the ovipositor. After this is completed the egg is deposited and the opening is sealed by a black gluey-like substance which is discharged from the ovipositor. Next the female makes a great number of small transverse incisions below the point where the egg is deposited with her mandibles. This is done so the bark in drying will raise like a blister and not crush the egg. During the period in which she is depositing the eggs the female often ascends to the end of the branch and begins feeding. In nearly all cases observed the female as well as the male fed entirely on the tender wood at the base of the leaf buds at the extremity of the branch. This feeding habit is not confined to the branches on which she is ovipositing but she may feed on other branches as well. The method of girdling varies but in most cases the cut is made entirely around the limb. The limb is seldom entirely severed but a small portion of the center is left intact. The weight of the limb, especially if the tree is

still in leaf, is sufficient to break off the limb and it drops to the ground. The egg when first deposited is snowy white in appearance, is oblong in shape and from 2.5 to 3 mm. in length, averaging 2.75 mm.

Injury

When nurseries are adjacent to forests the damage may be very severe and the greater amount of damage is caused by beetles which have migrated from other trees to the pecan. Many branches are severed which would bear nuts the succeeding year. In the nursery row small trees are severed near the ground and one insect may do a surprisingly great damage in that respect. The wounds made give an opportunity for fungous diseases to enter although this damage in our observation has not been well marked. Some damage is done in checking the growth of the tree. On trees whose branches are to be used as wood for budding, the loss is very great as this is the wood which is usually severed.

Life-History

The first females begin to emerge about the 25th of August and they continue to emerge until the first of October. After turning from the pupal stage they remain in the larval burrow for from 2 to 10 days and then emerge by eating a small round hole through the limb.

From 12 to 29 days after the female emerges, oviposition commences and continues in those cases we have observed until the female dies. The number of eggs deposited varies from 50 to 207 but the average female deposits about 175. Oviposition is begun by the first females the latter part of September and continues until in December. The greatest infestation occurs from the 12th to the 20th of October. In a few cases the females have lived until the last of December but most of them die by the first of December. The first freeze kills those that have not died from natural causes.

The females live from 42 to 84 days, and the males about the same length of time.

The eggs hatch in from 17 to 30 days after they are deposited, the average time of hatching being 23 to 25 days. The larva emerges from the egg by eating its way out by means of the mandibles. It at once begins to hollow out a small cavity in the branch and keeps on feeding all winter. Several larvæ may develop in one branch. A very small number of larvæ develop in proportion to the number of eggs that are laid so one seldom finds more than three or four larvæ in a girdled twig.

The larvæ burrow in the girdled twigs until the following summer, the larval stage lasting from 288 to 328 days. Before pupating the

larvæ eat a great number of small holes through to the outside. The larval burrow is also stopped with grass before the larva pupates.

Pupation takes place during the latter part of August and the first part of September. The pupal stage lasts from 12 to 14 days, and is passed in the larval burrow.

Control Methods

The method which had been recommended in the past, that of gathering up the fallen twigs and burning them in order to kill the larvæ, is practicable where a pecan orchard is not located in the vicinity of other trees. When forests are located near a pecan orchard there is always more or less migration from other trees to pecan trees. To meet such conditions we tried out a series of experiments with arsenate of lead and found it entirely effectual.

President Glenn W. Herrick: Is there any discussion?

Mr. S. J. Hunter: I would like to ask if Mr. Bilsing noticed any tendency of the female ovipositing at the base of the minor twigs? In the case of the elm twig girdler they invariably select the base of the twigs. I also wish to ask if the twig falls after being attacked by the girdler?

Mr. S. W. Bilsing: Regarding the first question I have seen females oviposit many times at the base of minor twigs. The damage is very much less to older trees as they are not injured to any great extent because the beetles do not cut off enough limbs to be of any consequence. Most of the limbs are cut two feet from the trunks of the smaller trees, and they are usually 10 mm. in diameter. As a rule the ovipositing is done in the main twigs. Many times the twig falls after being girdled by the female and she falls with it. This is especially so in windy weather.

President Glenn W. Herrick: Never at the base?

Mr. S. W. Bilsing: Yes, sometimes they deposit eggs at the base of the twigs. Occasionally the eggs are deposited in the middle of the twig.

Mr. W. C. O'Kane: I would like to ask if Mr. Bilsing maintained check cages in his experiment where other individuals were similarly confined, but without access to sprayed material? In other words did the specimens all die because of eating poison?

Mr. S. W. Bilsing: I will say that in the experiments shown in the chart I think all of them died from the spray material. I made several experiments later in the fall but could not consider the results accurate because of the beetles in the field dying under the

same conditions, but I think all the beetles in the cage experiments died from the effects of the arsenate of lead.

Mr. W. C. O'Kane: The question in my mind is whether some of the insects in your experiments may have died because they were in cages.

Mr. S. W. Bilsing: Where the beetles died in confinement they were in cages. Some are still in the small cages.

Mr. W. C. O'Kane: How large are the cages?

Mr. S. W. Bilsing: We carried on the experiments in small cages which were about 18 inches high, on the life-history of the insect, and checked up these conditions with the conditions in the field.

All of the beetles that were confined in large cages were dead in 48 hours and a part of them in 16 hours.

Mr. J. L. King: I would like to ask if all these beetles were of one sex?

Mr. S. W. Bilsing: I used both males and females in confining them in a cage. The males died just the same as females. Perhaps the males did not feed quite as much as the females.

Mr. H. A. Gossard: I would like to ask how the schedule for spraying pecans fits in with the schedule for destroying the case worm, the bud worm and other pecan insects; does this have to be an independent spray?

Mr. S. W. Bilsing: I have never done any work on the case worm but I do not believe it would fit in.

Mr. C. L. Metcalf: These experiments have been intensely interesting to me because of the parallelism between this species and *Oncideres cingulata* in North Carolina. I would like to ask Mr. Bilsing if he made any experiments to indicate the most favorable conditions for passing the winter? Whether he found any difference in the percentage of those that live through the winter when they were dependent on dry or moist conditions, and also how the limb was girdled when the twig sloped downward?

Mr. S. W. Bilsing: In answering the first question, I found in rearing material for my work, moisture had a great deal to do with the number of larvæ which survived. A small number lived over in the limbs which remained on the ground. In order to secure sufficient material it was necessary to tie a great number of these branches up to the limbs of various trees. In answering the second question I will state I have never observed any beetles girdling the branches which sloped downward.

Mr. R. W. Leiby: Have you noticed any egg parasites?

Mr. S. W. Bilsing: No. A considerable per cent of these insects are parasitized by a tachinid fly. I have not done a great deal of work on this but I expect to work on it in the future.

Mr. C. L. Metcalf: I wonder if Mr. Bilsing would care to tell us his method of keeping track of the females in order to find how many twigs they girdled.

Mr. S. W. Bilsing: My work along that line has not been very satisfactory. The first season I tried to keep track of these beetles by marking them with red and black ink on the wing covers. This was rather unsatisfactory. In order to determine the number of eggs deposited and the number of twigs girdled the past season, I followed up the plan of caging up some 40 insects in small cages in order to take complete notes of them. I found that the data collected in this way agreed in general with that collected in outside conditions.

Mr. C. L. Metcalf: Are the results on your chart all from laboratory tests?

Mr. S. W. Bilsing: Yes, all the data on my chart are laboratory tests.

President Glenn W. Herrick: I will now call for a paper by Mr. George G. Ainslie.

NOTES ON CRAMBIDS[1]

By Geo. G. Ainslie, *Entomological Assistant*, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Dept. Agriculture

The Crambidæ hold much the same position economically as cutworms, jassids and aphids. Like the poor they are always with us, and, though the injury they do is usually clandestine and unobserved, it is none the less real. Everyone interested in insects is familiar with the small whitish moths which in almost every locality, at some season of the year, swarm so thickly in the grass, but the larvæ of these same moths are so successful in concealing themselves that even some entomologists with considerable field experience are unacquainted with them. Very little has been published concerning their habits or from an economic standpoint. We are convinced, however, from our field work in Tennessee and neighboring states, as well as from material and reports of damage received from field men of the Bureau in other parts of the country, that the various species belonging to this family cause widespread damage every year. Two years ago we undertook an extended study of the group and it is with the hope of stimulating interest in these insects and obtaining records from a wider area that these brief notes are presented.

In his catalog in 1902, Dr. Dyar records 79 species of the subfamily Crambinæ from North America. Since then several new species have been described, so the number now recorded from North America is

[1] Published by permission of the Secretary of Agriculture.

somewhat over one hundred. More than half of these belong to the genus Crambus. In his systematic treatment of the same group in 1896, Dr. C. H. Fernald listed and described 82 species and varieties. In that work he also briefly summarized all that had been published up to that time on the biologies of the group with the result that 62 of the 82 species have, appended to the description, this statement: "Early stages and food plant unknown." For most of the other 20 species all the information given in addition to the description of the moth is a quotation of Dr. Felt's description of the egg and first instar larva and no facts are recorded as to their habits and life-histories. Since the papers by Felt and Fernald, a few lists of species occurring in various parts of the country have appeared, but, except in the case of one or two species, nothing has been done which adds to our knowledge. The necessity for such work is unquestioned. Thirteen species have been recorded in literature or found by us feeding on and injuring some field crop aside from meadow and pasture grasses. *Chilo plejadellus*, the rice stalk-borer, *Diatræa saccharalis*, the sugar-cane borer and *Diatræa zeacolella*, the larger corn stalk-borer of the southern states, the group of three closely related and possibly synonymous species, *Crambus caliginosellus*, *zeellus* and *luteolellus*, called generally the corn and tobacco webworms, and *Crambus hortuellus*, the cranberry girdler, all belong here and in addition there must be added to the list of species known to be injurious, *Crambus mutabilis*, the striped webworm, *Crambus teterrellus*, called by the late Miss Murtfeldt the bluegrass worm, *Crambus vulgivagellus*, the vagabond Crambus, *Crambus trisectus*, the dried Crambus, and a number of others of less wide distribution. *Crambus caliginosellus* alone every year necessitates the replanting and resetting of thousands of acres of corn and tobacco in almost every state east of the Mississippi. If anyone doubts that the grass-feeding species are capable of injury they can satisfy themselves by a perusal of Lintner's account of an outbreak of *Crambus vulgivagellus* in New York State in 1881 when hundreds of acres of pasture and meadow were left so bare and brown that large numbers of cattle had to be disposed of because of lack of food for them. A somewhat similar outbreak was reported by Professor F. M. Webster from northern Ohio in 1895. On that occasion fields of young corn and oats as well as meadows were swept entirely bare by larvæ, most of them probably *Crambus trisectus* and *mutabilis*.

So far as we have been able to discover in published records, not a single individual of any species of the genus Crambus, nor, I believe, of the family Crambidæ, had been reared completely through from the egg to adult in confinement until we succeeded in doing it at Nashville last year. Dr. Felt undertook rearing experiments with some sixteen

species at Cornell in 1892–3 but did not succeed in obtaining adults. His caged material all died during the winter, and, in the light of our experience, this was probably due either to a lack or to an excess of moisture. It is very difficult to keep the larvæ so that they will neither dry out nor be attacked by fungi because of too much moisture. Even though the adults are secured from larvæ reared on potted plants, little more is learned than the total length of the combined larval and pupal life. The first year of our work we obtained many adults in this way but found we were making little progress in getting at the number and description of instars. Larvæ cannot be dug out of the earth every day or two without affecting their health. As Rev. Thos. W. Fyles wrote after he had attempted to rear some of them some years ago: "At this stage I lost my specimens—the frequent disturbances necessary to the observation of their habits proving destructive to them."

In the fall of 1914 we began to experiment with the tin salve boxes which are proving so useful in rearing many kinds of insects and soon found that they satisfied every requirement. We transfer the larvæ as soon as they hatch to a one-half-oz. box containing a moistened disk of white blotting paper and a small piece of a grass blade or other food. With a little experience one is able to regulate the moisture and food supply to the age and species of the larva, for all species do not thrive under the same conditions. No earth or sand is used in the box. Most larvæ soon make a retreat of silk and bits of grass but they can easily be driven from this for examination and will return to it as soon as the box is closed. A number of checks were run to determine if the records of the duration of the various stages obtained with these boxes were comparable with those made under outdoor conditions and they agreed almost exactly, the new generation of moths often making its appearance in the outdoor check cages on the same day that adults emerged in the boxes.

We have reared a number of species through from egg to adult in this way, and, with each individual under observation every day, it has been possible to obtain beautiful series of larvæ preserved in each instar, as well as descriptions of the same made from the living larvæ.

Not all has been smooth sailing, however, for we soon found some species whose newly hatched larvæ, however politely they were treated, refused altogether to feed on anything we could offer them. We were especially disappointed to find this to be the case with the *caliginosellus-zeellus-luteolellus* group for we had hoped by rearing series of moths with known parents to unravel the relationships of this clan. *Crambus elegans*, *alboclavellus* and *laqueatellus*, in addition to *caliginosellus* and *luteolellus*, have so far failed to respond to any treatment we have been

able to give them. This is the more peculiar because partly grown *caliginosellus* larvæ taken in the field are easily carried to maturity on young corn either in boxes or in cages. There is apparently some condition required by the larva in beginning to feed which we have not yet supplied. Such a case was met with in attempting to rear from the egg, larvæ of one of the burrowing webworms, *Anaphora popeanella*. The newly hatched larvæ refused fresh food but by accident it was discovered that in a box which had been thrown aside, the larvæ were feeding on partly decayed leaves and thriving. A little later in life they prefer fresh food and reject the other.

In other respects Crambid larvæ vary greatly. Some species, such as *Crambus mutabilis, teterrellus, præfectellus* and *trisectus,* continue to feed and grow as long as the weather is favorable, and, except for those larvæ which are overtaken by the winter when only partly grown, pupate as they reach their growth. They thus have several generations in a year, the exact number varying with the latitude and altitude. Others as *Crambus hortuellus, vulgivagellus, ruricolellus* and probably *laqueatellus* have one distinct generation each year and, instead of pupating when full grown, the larvæ construct their pupal cells and then spend several months in meditation.

There is enough variation in the habits of the species to make the study of this group very interesting and a knowledge of the seasonal history and habits of the particular species involved is also essential whenever it becomes necessary to formulate methods of control. We hope to develop keys based on larval characteristics so that the identity of injurious forms can be determined without waiting for the adults to emerge, which sometimes requires several months. We shall be glad to determine collected or reared species of Crambidæ for the sake of the data on geographical and seasonal distribution accompanying them.

President Glenn W. Herrick: Is there any discussion of this interesting paper?

Mr. E. P. Felt: I would like to ask Mr. Ainslie if he has made any serious attempt to control this grass web-worm?

Mr. George G. Ainslie: I have done nothing in this direction.

Mr. E. P. Felt: We have more or less trouble in New York. I have been wondering if it might not be possible to destroy a good many of these web-worms by arsenical applications. In my studies I distinctly saw the young larva come up and cut off grass blades and

take them down into the burrow. I wonder if there would not be a time when it would be possible to destroy the larvæ of these grass web-worms. I am trying to find some place to try that out.

MR. H. A. GOSSARD: A few years ago, there was quite an outbreak in Paulding County, Ohio. Several fields of corn and oats were practically destroyed in a very short time.

I carried on a few experiments but I did not find any satisfactory means of control. The experiments made were not on very large tracts, but some were on half-acre or quarter-acre plots. The corn maggot was also present. In the same fields we tried out some of the Cooper's Apatite or soil fumigant, some iron refuse that had been used for cleansing artificial gas and tobacco dust, thinking the latter could be distributed like fertilizer when the corn was planted.

Neither the web-worms nor the seed-corn maggots were repelled from the hills, and growth of the plants was interfered with in case of all the materials except the tobacco dust. The web-worm concerned was *Crambus trisectus*.

MR. HERBERT OSBORN: The web-worm was troublesome here in Ohio last year, but not especially in the vicinity of Columbus.

My first acquaintance with these insects was nearly thirty years ago in Iowa and some of my observations were recorded in the Report of the Department of Agriculture for 1887. The moths were so abundant at that time that they caused much annoyance by flying around lights in houses.

I do not think Mr. Ainslie has exaggerated at all the damage they may do.

One point that seemed to come out distinctly was the possibility of controlling the insect where sod was to be turned into corn. Eggs were laid on grass land and with corn planted later on the same ground much injury occurred. A difference in ten days in plowing determined whether the corn was destroyed or not.

PRESIDENT GLENN W. HERRICK: I was very much interested in Mr. Ainslie's methods of breeding the insects.

It agrees with some experiences we have had in rearing the clover leaf weevil. They seemed to deposit eggs and get along better when kept in the small salve boxes than when we put them in a large cage with clover plants.

I think this is a very interesting piece of work and I hope Mr. Ainslie will keep it up.

If there is no more discussion of this paper we will pass to the next one by Mr. Wm. P. Hayes.

A STUDY OF THE LIFE-HISTORY OF THE MAIZE BILL-BUG[1]

By WM. P. HAYES, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

The maize bill-bug (*Sphenophorus maidis* Chittn.), a rhyncophorous beetle belonging to the family Calandridæ, is commonly known in localities where it does injury to corn as the "elephant bug" or "corn bill-bug." Reports of damage by this insect in Kansas date back twenty years (1895). Although the species has been taken as far north as the Kansas River, its injury to corn has been confined almost entirely to the fertile river valleys in the southern part of the state.

Previous to 1905, when Chittenden described *Sphenophorus maidis* as a distinct species, the ravages of this insect were attributed to *Sphenophorus robustus* Horn and *Sphenophorus pertinax* Oliv., particularly the former. Thus the earlier references to this insect have been confused with these two closely allied species. The earliest records of this pest, in the Department of Entomology of the Kansas Agricultural College, date back to 1896–97 when, under the name of "elephant bug," it was reported doing damage to corn on Wild Cat Creek, eighteen miles east of Eldorado. Kelly (1911, Bul. 95, Bu. Ent., U. S. Dept. Agr.), however, reports it one year earlier from three localities in Kansas.

During the seasons of 1914 and 1915, the writer was detailed in southern Kansas to study this and other injurious insects of that region. The results obtained during that time are herewith set forth.

DISTRIBUTION

Sphenophorus maidis has been recorded from the following places: Alabama, Georgia, South Carolina, Texas, Michigan, Oklahoma, Arkansas, and the following places in Kansas: Augusta, Madero, Florence, and Riley County. Two specimens were found in the entomological collection of the Kansas Agricultural College, one labeled "Topeka, August 11, 1911," and another labeled "Wichita" with no further data. From these scattered reports there seems to be no doubt that it is distributed over most all of the southern states.

Since the study of this form was taken up, *Sphenophorus maidis* has been taken in the following places in the state: Winfield, Arkansas

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 15. This paper embodies the results of some of the investigations undertaken by the author in the prosecution of project No. 92 of the Experiment Station.

City, Hackney, Dexter, Rock, Kellogg, Leon, Marion, Peabody, and Greenwood County.

The bill-bug is found principally along river bottoms, where its greatest damage to corn is done. It is also found doing slight injury on the second bottom land and rarely on upland. In neither case is the damage appreciable compared to the lowland ravages. In lowlands, preference is also shown to plants on heavy gumbo soils, corn on sandy soils being not so seriously injured.

Means of Dispersal

The rate of dispersal of the maize bill-bug under natural conditions must necessarily be slow, for, although wings are present under the elytra, the insect was not once observed during the two seasons to attempt flight. Because of this fact, adults were easily kept all summer in open Mason jars.

Floods are probably a small factor of dispersion. During the 1915 season, three adults were observed being carried by the high waters but, as a rule, during floods they burrow into the soil and are unaffected. Adults can live for many hours in water. Mr. J. C. Delaney reports an uninfested field some years ago becoming infested after a heavy rain from water coming from a higher, infested field. Driftwood may play an unimportant part in their spread.

In two southern Kansas counties, two theories are held to account for the introduction of the "elephant bug." In Greenwood County, the farmers along Wild Cat Creek are positive that a Mr. Chain introduced them from Texas with cattle bedding about 1896. In Cowley County on Grouse Creek, a Mr. Barney Ish is accused of introducing them in the same manner.

Character of Injury

The corn plant is subject to damage from both the adult and larva. Feeding punctures of the adult kill a large number of young plants soon after they break through the ground. The punctured plants do not show much damage externally but closer examination reveals large cavities gouged out beneath the narrow, slit-like opening. These punctures, if made in a curled leaf, will cause it, when unrolled, to show rows of holes similar to the damage done by the smaller bill-bugs. These feeding holes are made either just below or above the surface of the ground. Sometimes they are made in the germinating seed and even in the tender roots. This feeding generally causes the plant to become twisted and distorted and many are killed outright. Similar punctures were observed in cane and kafir, both in the field and laboratory. In rearing cages, punctures were likewise made in feterita

and sweet corn when no other food was available. Young plants are often slightly injured by adults clasping their feet around the stalk and piercing the epidermis, making six rather deep holes.

Plants that survive or escape injury from the feeding of the adult are subject to damage from larval feeding. While oviposition punctures may not seriously harm the plant, yet the resultant larva begins its damage by burrowing up or down from this point. If it begins to work up it will finally turn and work towards the tap-root. The larva, burrowing the stalk, does not always kill the plant, but causes the upper leaves to take on a wilted appearance and the whole plant becomes distorted. Infested stalks seldom bear ears but do produce numerous suckers.

Food Plants

Larvæ were not only successfully reared in maize, but also in cane, kafir, sweet corn, and feterita. Adults likewise fed on these same plants when confined in cages without other food. In the field, they were found feeding on kafir and cane that had been planted on infested corn land. In the spring of 1915, dead larvæ and pupæ were found in kafir stubs. A single adult was found by the author feeding on one of the rosin plants (*Silphium integrifolium* Michx.) and one writer found all stages, except the egg, of this insect in swamp grass (*Tripsacum dactyloides* Linn.). Continued search in this grass at Winfield, Kansas, failed to reveal any trace of them even alongside of infested fields.

Adult

Upon shedding the pupal skin, the adult is light brown in color, varying from red to a whitish-yellow in the body sutures and striæ of the elytra, but after two or three days they become thoroughly pigmented, assuming a reddish-black color.

In 1914, mature bugs were found in the field as early as July 29, while in 1915, none were found until September 2. However, in rearing cages in an outdoor insectary, they began to appear August 16. This difference in time of appearance in 1914 and 1915 is undoubtedly due to climatic conditions, the former being a hot, dry year, while the latter was unusually cold and wet. Other differences to be mentioned later, such as variation in length of egg, larval and pupal stages, can probably be attributed to this same cause.

In the fall, after becoming adults, many bugs emerge from their pupal cells by gnawing their way out through the lower end of the corn stalk, and it is claimed, but not corroborated, that they pass the winter in the soil. Adults were kept alive for over a month in soil where they often formed cells by compacting the earth around them. The majority of adults, however, pass the winter in pupal cells con-

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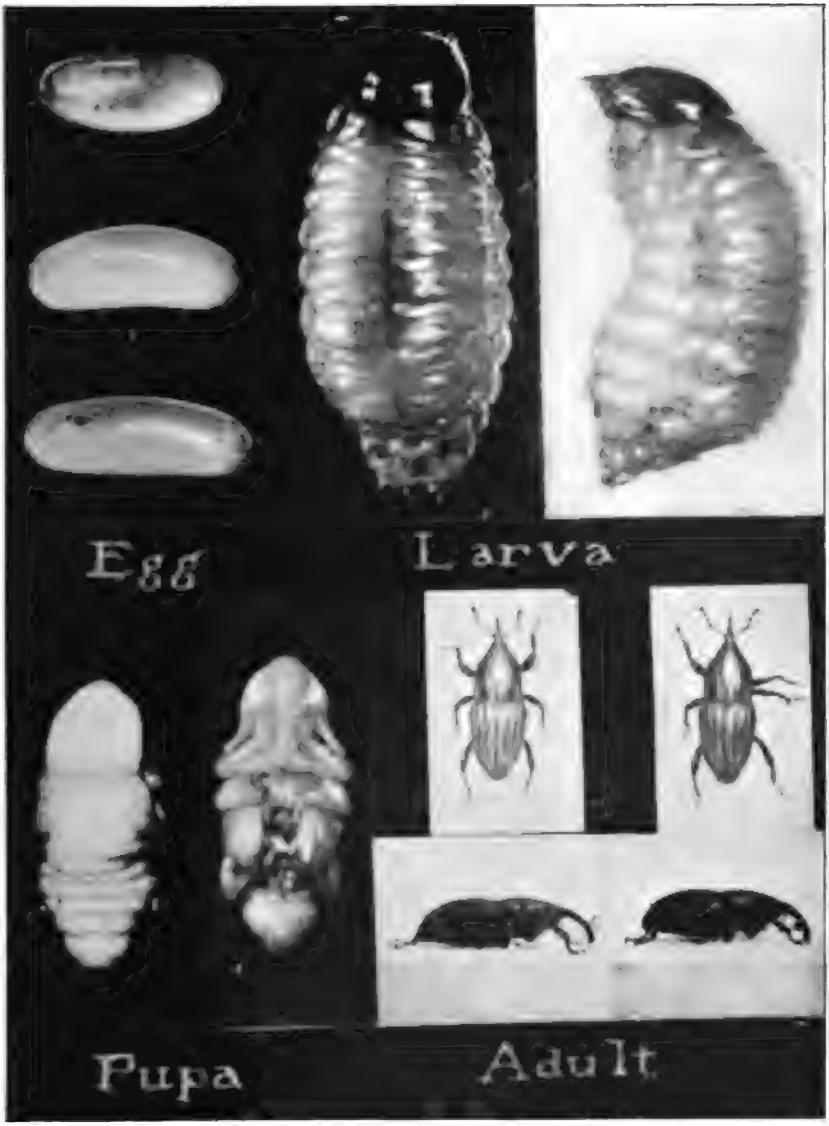
Maize bill-bug: 1, Infested roots and pupa in burrow; 2, Plants showing injured root system



Maize bill-bug, various stages

independent burrows in the same plant, a condition often found in badly infested fields. Adults, pupæ, and larvæ may frequently be found in a single stalk.

After becoming established in a stalk of any size, they were never observed to burrow through the tough, outer covering of the plant above ground, but may do so occasionally beneath the surface.

The length of the larval stage varies considerably. In 1914, on corn, it ranged from 40 to 60 days with an average of 52.5 days. The following table shows the length of the larval stage in 1915 on different food plants:

LENGTH OF LARVAL STAGE

Food	No. Attempted to rear	No. Matured	Max. Days	Min. Days	Aver. Days
Maize..................	337	141	69	32	42.83
Kafir..................	47	6	68	32	47.50
Cane..................	46	12	75	39	54.83
Feterita..................	34	7	52	38	44.42
Sweet Corn..............	13	3	56	43	48.00

In 1915, the average length of the larval stage, on maize, was reduced from 52.5 to 42.83 days, almost ten days in a much cooler season. The minimum was also lowered from 40 to 32 and the maximum raised from 60 to 69 days. These results were obtained in an outdoor insectary and checked closely with field observations. One larva, feeding on cane, was kept alive 123 days, but died before pupation.

Although larvæ were found at work in the fields as early as June 6 in 1914, they were not found until July 1 in 1915 and were present thereafter throughout July, August, and part of September.

PUPA

Pupation occurs in the pupal cells constructed in, or near, the taproot of the infested plant. Pupæ are generally found in the upright position which the larvæ assume just before transformation. At first, they are creamy-white, but in from 4 to 6 days they begin to gradually darken until they are nearly the color of new adults.

The pupal, like the egg and larval stages, varied considerably in the two seasons under observation.

LENGTH OF PUPAL STAGE

Year	No. to Pupate	Max. Days	Min. Days	Aver. Days	Remarks
1914..................	11	13	10	11.4	Dry season
1915..................	114	30	9	13.84	Wet season

SEASONAL HISTORY

There is but one generation annually. Adults that have lived through the winter will sometimes be abroad after their progeny are matured.

The following unsuccessful attempt was made to get a second generation or at least a partial brood. Three sets of males and three of females that had matured since August were placed in cold storage in September. One set was left one week, the second two weeks, and the third three weeks, at a temperature varying from −4°F. to +12°F. These were then removed to a greenhouse and the males and females put together and given summer conditions. No mating occurred and all adults soon died. A check, run under natural conditions, also failed to produce a second generation.

Concerning hibernation, more work is necessary. A large majority pass the winter in their pupal cells, but those leaving the stalks in late summer and early fall must be accounted for before winter methods of control can be thoroughly successful.

Summing up the seasonal appearance of this bill-bug, we find the adults present in fields throughout the fall, winter, and larger part of summer, eggs in May, June, and sometimes July, larvæ from the first part of June to the middle of September, while the pupæ are present from the latter half of July to the last of September.

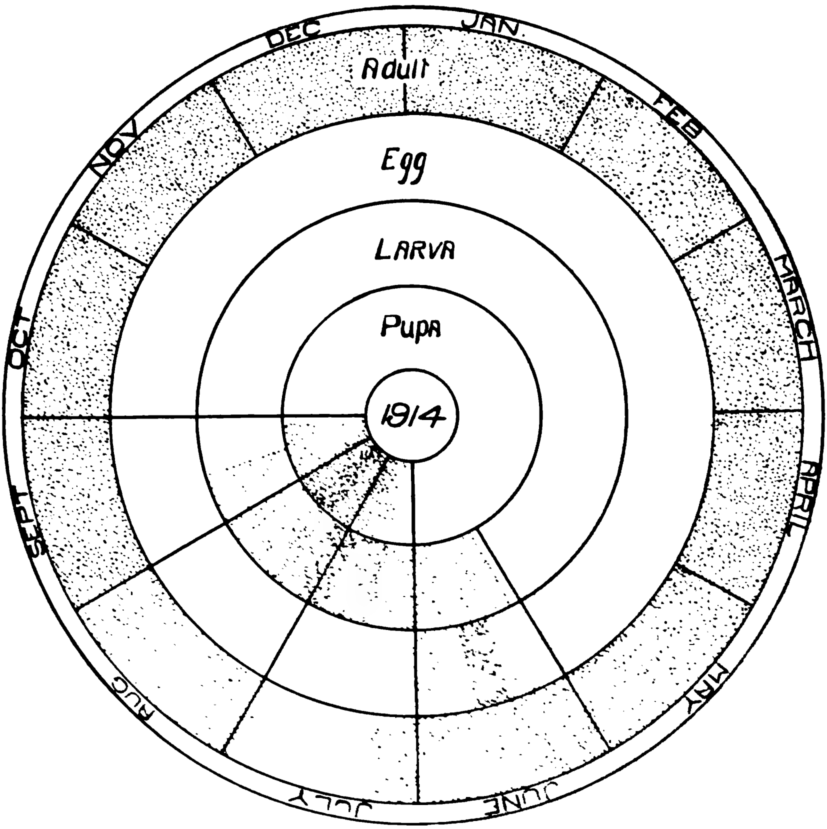


Fig. 9. Diagram representing the seasonal appearance of the maize bill-bug

Natural Enemies

Unfortunately, this insect apparently has few natural enemies since, to date, none have been recorded. This scarcity may, in part, be attributed to the protection which is afforded by its habit of living, the greater part of the year, in the corn plant.

Near the close of the 1915 egg-laying season, four dipterous larvæ were found living in a single egg, the only instance of apparent parasitism to come under observation. The Diptera were not bred out but it is the intention to further investigate this parasite during the coming season.

Predaceous enemies often gain entrance to the larval burrows, especially when the tap-root rots in the soil. Chief among these are carabids, elaterids, and ants. The following is a list of enemies found attacking the different stages:

- Attacking egg—
  - Parasitic
    - Unknown Diptera
- Attacking larva—
  - Predaceous
    - Carabidæ—adults and larvæ
    - House ant (*Monomorium pharaonis* Linn.)
    - Little thief ant (*Solenopsis molesta* Say)
- Attacking pupa—
  - Predaceous
    - Elateridæ—larvæ
    - Corn field ant (*Lasius niger americana* Emery)
    - House ant (*Monomorium pharaonis* Linn.)
    - Little thief ant (*Solenopsis molesta* Say)
- Attacking adult—
  - Predaceous
    - Carabidæ—adults
    - Little thief ant (*Solenopsis molesta* Say)

Control Measures

The cheapest, most satisfactory, and practical method of control is the use of a cropping system in which corn does not follow corn. It should be succeeded by some crop that is not subject to injury by this pest. In southern Kansas the best general practice has been found to keep the infested fields in alfalfa for a few years after which corn may be safely planted.

The pulling up and burning of stubble has hitherto been recommended as an efficient remedy in controlling this species. This is a very laborious and impractical task on a 60- or 80-acre field and is not very

effective because many beetles leave the tap-root in early fall and, as yet, their winter quarters are not definitely known. Moreover, infested plants break off easily when pulled out and often, even when the greatest of care is exercised, beetles are left in the lower part of the tap-root.

Swamp grass in and around infested fields should be destroyed as well as volunteer corn or sorghums. As in the control of many other insects, weeds, rubbish, and trash should be cleaned up to destroy hibernation quarters.

President Glenn W. Herrick: Any discussion of this paper on the maize bill bug by Mr. Hayes?

Mr. William Moore: I would like to ask Mr. Hayes if he ever tried cutting stalks off quite low, if there was any difference in the successful hibernation of the insects?

Mr. William P. Hayes: In fact it is the best way to get a supply of beetles, to pull up the roots in the spring.

Mr. William Moore: The reason I ask is that in South Africa an insect hibernating under similar conditions can be controlled if the stalks are cut low. They freeze out when the weather is 15 or 20 degrees above zero.

President Glenn W. Herrick: Moths or beetles?

Mr. William Moore: Moths, *Secamia fusca.*

Mr. A. H. Beyer: In my observations in the south in one field in particular where the stalks were cut low and lots of trash had accumulated, I did not find any change. They hibernated as well in the fields adjacent.

Mr. Z. P. Metcalf: There is one thing that I would like to say about a nearly related species (*Sphenophorus callosus* Oliv.) that we have in North Carolina. In the fall of the year all the adults evidence a desire to take to flight; at no other time of the year have we noticed any attempt on the part of the Southern corn bill bug to fly, in fact earlier in the season our mated pairs have frequently been left in open cages for days at a time and the beetles made no efforts to escape. This, together with the fact that the adults seem to disappear from the fields very suddenly, leads us to believe that there might be a fall dispersal flight but so far all our efforts to demonstrate such a flight have been without success.

I would like to ask Mr. Hayes if he has observed any such flight, for although our evidence is purely circumstantial it seems to point in that general direction and I thought that perhaps someone else had been more successful in making these observations than I have.

Mr. William Hayes: I have had no experience in that line but I thought it was mice that carried off the missing bugs. I have always kept them in open cages. I do recall one instance sometime in the fall that I wondered at the disappearance of several bugs out of a certain cage. It is possible they might have flown away.

Mr. Z. P. Metcalf: I do not attribute the sudden disappearance of the Southern corn bill bug from our open cages to the work of mice for I actually saw them fly away.

Mr. F. M. Webster: I would like to ask if anybody has any proof of their leaving the field at all. Where corn follows corn, if you alternate by a crop of cotton, no difficulty results with the next crop. One of these species was worked over and published by the Bureau of Entomology. I believe where corn has followed corn for two or three years, a rotation of crops, except of kafir or something of that sort, is necessary.

Mr. Z. P. Metcalf: In our experience in North Carolina we have not been able to find any constant differences where corn follows corn or where corn follows cotton. As a general principle the corn bill bug is worse where corn follows corn but this is not always the case. And from our experience it is not safe to recommend crop rotation as the only remedy necessary for the control of the Southern corn bill bug. I have in mind now a field of considerable elevation where the corn bill bug was worse, although the field was in cotton the year previous, than it was in an adjoining field of lower elevation and hence more likely to be attacked by bill bugs that had been in corn the year previous. This same condition has been noted in various localities and I would like to ask Professor Webster, therefore, if there was not some other factor of more importance than crop rotation involved in the field of corn on the "Shannon house place" which is illustrated in his bulletin on the "Curlew bug." A heavy application of fertilizer will make corn grow very rapidly and escape the attack of the corn bill bug. And in the past cotton farmers have been in the habit in North Carolina, at least, of making heavy applications of fertilizer to cotton and none or only a very light application to corn. A great deal of this fertilizer might be held over in the soil until the following year when it would make its presence felt on the corn crop. Time of planting is also a very important factor in the control of the corn bill bug. Either one of these factors might account for the fact that one could tell to the very row which part of the field had been in cotton the year previous and which part had been in corn but from a pretty extended study of this insect in the field, it is hard for me to believe that there would be anything in the mere fact that the field had been in cotton the year previous to prevent the corn bill bug from attacking the corn.

MR. F. M. WEBSTER: I do not think any fertilizer was used at all. There might be a difference between the low land and the high land in North Carolina.

MR. Z. P. METCALF: The reason I mentioned the fact that the field in which corn followed cotton was a field of considerable elevation whereas the field in which corn followed corn was much lower, was because all other things being equal corn bill bug injury is much worse in low fields than it is in high fields, yet here was a case the exact reverse of this. I do not wish to leave the impression that crop rotation is not of some benefit in our fight against the corn bill bug. What I wanted to say was that I can see no reason why the corn bill bug should not spread to fields that had been in cotton the year previous. At least I can see no reason why the corn bill bug should stop in adjoining fields at the very row where the cotton field commenced, unless there was some other factor, such as time of planting or kind of fertilization involved.

MR. H. A. GOSSARD: I would like to ask if any of these gentlemen can tell me if there is any evidence that stirring or cultivating the infested land has any effect on the insects; by being disturbed they might be excited to flight and leave the field? A few Ohio farmers have written me that by very industriously cultivating the corn at the time of attack, the attack ceased.

MR. Z. P. METCALF: We have tried thorough cultivation in the same plot with practically no cultivation and while corn does not grow as well where it is not cultivated yet it was impossible to notice any very great difference in the amount of injury between the cultivated plot and the uncultivated plot.

MR. WILLIAM HAYES: I know of a field where the corn was burned in early spring. I found bugs in the stumps after the fire had passed over them.

MR. S. J. HUNTER: As I see it, Mr. Hayes has placed the emphasis on the right point; viz., rotation of crops.

In the case of the Diabroticas in corn it has been our experience that no serious injury occurs until after corn has been planted in the same ground for three years or more.

PRESIDENT GLENN W. HERRICK: We will now have the next paper by Mr. Schoene.

THE ECONOMIC STATUS OF THE SEED-CORN MAGGOT (PEGOMYA FUSCICEPS ZETT.)[1]

By W. J. Schoene, *Blacksburg, Va.*

This insect is known as the seed-corn maggot, though it is said to injure sprouting beans and peas, seed potatoes, and the roots of cabbages and onions. The early history of the species has been fully treated by Slingerland,[2] Chittenden[3] and others. *P. fusciceps* attracted much attention during our study of the cabbage maggot and at times it was difficult to tell from collections of adults which was the more important species. There have been some specimens of *fusciceps* in practically all our collections of adults of *P. brassicæ*, the numbers varying with the season and the location where the flies were captured. In one experiment in which the adults of *brassicæ* were collected as they emerged from a badly injured cabbage seed-bed[4] the males of this species constituted 23 per cent of the total number of males. In sweepings of pea-fields or wild mustard, males of *fusciceps* were frequently more numerous than those of the associated species.

Because of the uncertainty of the part played by this insect, some efforts were made to ascertain its habits and to find its other hosts. To that end many large fields of peas, beans and potatoes in Ontario county, New York, were examined for injured plants. However, very few infested plants were found and for a period of eight years only a few cases of injury were ever reported from that region, though peas, beans and potatoes are among the principal crops. In spite of our efforts, the importance of the insect was a matter of some doubt until the following observations were made.

During the autumn of 1911 a number of examinations of the crop remnants of a cabbage field were made to secure material for breeding experiments. The field in question contained a large number of sprouted cabbage heads; that is, heads that had ripened and then because of abundant moisture had put forth new growth. These heads contained terminal sprouts eight to fifteen inches high. After the head is broken it is no longer marketable, so these had been left in the field after the crop was harvested and many of them had become infested with maggots. Apparently the eggs had been deposited

[1] Contribution from the Department of Entomology of the New York State Experiment Station, Geneva, N. Y.

[2] Cornell Agr. Exp. Sta. Bul. 78, p. 499.

[3] U. S. D. A. Ent. Bul. 33, p. 84.

[4] Jour. Eco. Ent. 4: 210.

at the point where the sprout had broken through the head. These sprouted cabbages were in various stages of decay. Some of the decayed parts of such plants contained a number of *fusciceps* larvæ, while heads that were not decayed contained no *fusciceps* larvæ, although more or less infested with larvæ of *brassicæ*. These conditions suggested that the laceration of the plants by the larvæ of *brassicæ* and the development of areas of decaying tissue had made the heads attractive to *fusciceps*. In all our examinations of material in which *brassicæ* larvæ were breeding there has been every indication that this species prefers sound tissue. This fact, when considered in connection with the well-known range of food materials of this species, has led us to believe strongly that at least in this instance *fusciceps* was largely a secondary pest of the cabbage, attacking the plants only after rotten tissues developed.

However, in going over some of the accounts of the work of *P. fusciceps* it is evident that some entomologists have believed the insect to be capable of causing injuries to growing crops. Chittenden[1] states that "the seed-corn maggot was observed during April and May doing great damage to late planted beans in the vicinity of Diamond Springs, Va. In certain areas rows were entirely killed off, necessitating replanting." Also, "during the spring of 1909 extensive injury to seed potatoes was incurred in Tidewater, Virginia."

Although *P. fusciceps* has been reported as injurious many times there are a few writers who have suggested that cool, wet weather has something to do with the appearance of the insect in sprouting seed. Fletcher[2] says, "Corn sown during a cold, wet period by which germination is unduly delayed is very liable to be attacked by the corn-seed maggot." During 1910 the farmers in certain sections of the central west became much alarmed because large areas planted to corn failed to germinate and upon examination found the seed to be infested with small worms. Regarding the outbreak, Dr. Forbes[3] makes the following statement: "The insect injury is due to two insects, called respectively, the black-headed grass maggot and the seed-corn maggot, both of which are particularly liable to infest seed corn which has been in the ground a long time, either dead and decaying, or softened and possibly sprouting, but delayed in growing. Injuries by these insects are at present, I think, not so serious as they seem, the main damage being done by the weather."

In conclusion, there are positive indications that the insect does occasionaly feed upon partially decayed matter, but we have no

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[1] Va. Truck Exp. Sta. (Norfolk) Bul. 2, p. 34.

[2] Central Exp. Farms Ottawa Bul. 52, p. 35–36.

[3] Ohio Farmer, p. 702, 1910.

evidence to show that it will not also feed upon healthy plant or animal tissue. It is believed that if entomologists would study the conditions favoring the development of large numbers of *P. fusciceps*, its economic status would soon be determined.

MR. J. M. ALDRICH: Recently in Michigan I had a conversation with Professor Pettit, and he told me that this fly is very injurious to beans in that state, destroying the young plants. I also heard the same complaint about its habits in Canada, when I was lately at Ottawa. It seems to be very important.

MR. T. H. PARKS: In regard to the injury this insect does to beans, I wish to add a little to what Dr. Aldrich has said. In southern Idaho during the spring of 1914 *Pegomyia fusciceps* appeared in wholesale numbers in bean fields, the maggots attacking the sprouting beans after the young plants had developed the second leaf. Inasmuch as the young plants were soon killed, there was certainly circumstantial evidence that the maggots were attacking the living plant beneath the surface, and also the sprouting seed. The injury extended over several large areas ranging in altitude from 2,800 to 4,500 feet, and in some cases the crop was entirely destroyed. They were also seriously injuring potatoes and in some cases where potatoes followed a wheat crop of the previous year.

I reared *P. fusciceps* from maggots found in the "bulbs" of young wheat plants in Kansas in 1909, and can add this host plant to the list presented by Mr. Schoene. It is doubtful if wheat constitutes a favorable host plant for this insect, although in Idaho I have noticed serious infestation to potatoes where this crop followed wheat.

MR. N. F. HOWARD: This species formed a considerable per cent of 10,000 adults of the three species (*brassicæ, fusciceps, cepetorum*) caught at Greenbay, Wis., last summer. It was also found hibernating in the pupal stage in onions, and was bred from both cabbage and onion.

MR. GEORGE A. DEAN: In Kansas, I found in two or three cases that corn was badly infested where it followed wheat. I do not know whether the maggots infested the wheat planted the previous year, but I did find that it was much worse in the two or three corn fields which followed wheat.

PRESIDENT GLENN W. HERRICK: We will now hear the paper by Mr. J. G. Sanders.

RECORDS OF LACHNOSTERNA IN WISCONSIN

By J. G. SANDERS, *Madison, Wis.*

(Withdrawn for publication elsewhere)

President Glenn W. Herrick: I know there are many comments that could be made on this but we thought it might be best to defer discussion until we have had the paper by Mr. Davis.

A REPORT ON WHITE GRUB INVESTIGATIONS

By J. J. Davis, *West Lafayette, Ind.*

(Paper not received in time for publication)

President Glenn W. Herrick: Now these interesting papers are open for discussion.

Mr. E. P. Felt: I wish to inquire if any attempt has been made to destroy the white grub in the fall before it goes any depth into the soil? In September I found them mostly a quarter or half an inch below the surface. I wonder if there is any way of destroying them early.

Mr. J. J. Davis: We have made no effort to destroy them except by fall plowing. It cannot be depended upon to control the grubs except in years when they are transforming to pupæ and then fall plowing, especially early plowing will destroy from 75 to 95 per cent of the prepupæ, pupæ, and recently issued beetles.

Mr. G. G. Ainslie: I should like to ask Mr. Sanders if he can tell the proportion of sexes that came to light at night?

Mr. J. G. Sanders: We have no records in Wisconsin regarding the time of appearance of sexes in evening flights. It takes a great amount of work in collecting and determining large numbers of beetles. We were assisted in this work by Mr. Neal F. Howard and Mr. Stewart C. Chandler.

Mr. T. J. Headlee: The white-grub problem in New Jersey appears to differ from that which has been described. Most of the damage has been done to lawns, golf greens and strawberry fields. In none of these places, except in the last, can we use the means of control ordinarily recommended. Because of this fact we have made preliminary trials of soil fumigants. The tests with carbon bisulphide indicated that three quarters of an ounce to the square foot would be sufficient to destroy all the grubs infesting red-shale soil, providing the work were done when the soil was just wet enough to work well and the temperature 70° to 75° F. The experiments in the same series indicated also that one ounce of the carbon bisulphide per square foot would not seriously injure blue grass or white clover under the conditions of temperature and moisture above stated.

Mr. William Moore: I was interested in Mr. Sanders' paper as we have been doing a little white-grub work in Minnesota. The one

point I was rather interested in—he speaks about the differences of distribution of species in small areas. In Minnesota we find a predominance of *L. fusca* in southeast Minneapolis, while in St. Anthony Park, three or four miles distant, we found *L. rugosa* most abundant. In Stillwater there is a large per cent of *fusca* and *dubia*. We found *dubia* and *grandis* were northern species. On the north border in collecting we found them very abundant on the west and again while coming in on the eastern border, while the central showed *grandis* most abundant. One collection at Stillwater, where we worked three-fourths of an hour, we found *grandis, dubia* and *fusca*. I was surprised at the predominance of females as you usually find a predominance of males.

Mr. J. G. Sanders: In taking records of individuals it is necessary to make note of the rate found in the early part of the flying season. After the middle of the season we find ten to one of *fusca*.

Mrs. L. C. R. Smyth: I happen to be rather familiar with the life-histories in Porto Rico and was interested in one of the discussions with regard to variation of occurrences. Porto Rico is some forty miles wide and the species that occur on the northern portion are quite distinct from those on the southern. They have not been identified but have been given locality names.

The life-history of one species covers a period of from two to five years. I happen to know that in Porto Rico the life-history of another species of white grub has been shortened to seven months, from the laying of the egg to the issuance of the adult beetle. A number of species may pass their life-history in thirteen months. The climatic conditions are such that they do not need to bore deep into the earth. The average temperature in summer is 72° and in winter 70°.

Mr. J. J. Davis: I would add that there seem to be at least three factors limiting the distribution of different species, namely—soil, trees and elevation. Certain species are found in sandy soils which do not occur elsewhere and vice versa. The food preference of the different species of beetles varies considerably as is shown by our collection records. The effect of elevation is well shown by our collections at Lafayette where we have three elevations; one along the Wabash River which is sometimes overflowed, one a little higher up, say about 75 feet, and a third about two miles back which is probably 75 to 100 feet higher than the second elevation. In the lowest area at Lafayette and in the low ground elsewhere in the state we find *Lachnosterna vehemens* common and not occurring at the higher elevations and adversely we find species which occur only on the highest elevations.

Adjournment, 5.00 p. m.

AFTERNOON SESSION

Wednesday, December 29, 1915, 1.30 p. m.

PRESIDENT GLENN W. HERRICK: We will have the first paper this afternoon by Mr. Schoene.

NOTES ON THE BIOLOGY OF PEGOMYA BRASSICÆ BOUCHÉ[1]

By W. J. SCHOENE, *Blacksburg, Va.*

This paper deals with some conditions that affect the number of broods. The spring brood of adults or those emerging from the over-wintering pupæ, are comparatively regular in their time of appearance. This fact has been vouched for by many entomologists. The time that the first flies emerge in the spring depends somewhat upon the weather. During six seasons the first individuals were taken about the time the Windsor cherries were in bloom, or between the 1st and 16th of May. By covering small areas of infested cabbage fields with cloth screens, and catching the flies as they came from the soil, it was learned that the adults emerge during a period of five weeks or longer. Our results also suggest that the time the flies first appear in spring may be influenced by such characters as type of soil, depth to which the field has been plowed, and the slope of the land.

The adults maturing in mid-summer are very irregular in their time of appearance. There are probably several factors that contribute to this irregularity, but it is primarily because the younger stages of the insect are affected by the weather, and that the pupal stage may be greatly prolonged. This irregularity in the life-history of the insect was noted by Slingerland, who states as follows: "Most of the puparia under our observation gave out the flies in about twenty days, in June; with some it lasted only fifteen days, with quite a number, nearly two months, with others three months. . . . ." Slingerland also observed that, "these are very surprising facts when one understands that all of these puparia came from the first brood of maggots. There is no hint in literature to any such retardation in development." We have noticed this delay of development as described many times. At first it was believed to be due to unnatural conditions maintained in the breeding cage. However, by placing the insects outside, and by screening portions of fields containing infested plants, we learned that the retardation behavior mentioned by Slingerland occurs regularly, each summer, in western New York.

[1] Contribution from the Department of Entomology of the New York State Experiment Station, Geneva, N. Y.

After this fact had been determined certain simple experiments were initiated, the results of which have shown that this delay or retardation is much more apparent under some conditions than others. These results are stated tersely as follows: First, when the puparia were held at a temperature in which the daily maximum readings averaged 78° F. and the minimum readings averaged 56° F., the so-called delay in development was practically absent, only a small percentage of the individuals being affected. Second, when the puparia were held at a high temperature, such as frequently occurs in western New York, a small number completed their development several days sooner than usual, while others remained quiescent and showed no visible development, while the high temperature was maintained. By holding these retarded individuals at a low temperature some were able to finish their development, though many died.

This behavior of the species has been interpreted in the same way as that outlined by Osborn[1] and Webster[2] for the Hessian fly, which is, namely, that high temperature or severe drouth causes a retardation of developing larvæ and pupæ, which lasts until low temperature returns.

The effect of this retardation behavior on the life-history of the insect in western New York is very apparent by a study of breeding records and observations made during the summer of 1909 and 1911. In 1909 there were three well-marked broods of adults. The first brood emerged during the latter part of May and the first of June; the second brood flies appeared during the latter part of June and continued to emerge through July, and the third brood emerged during the period of August 26 to September 27. These data were secured by covering large numbers of infested plants with cloth screens and capturing the adults as they issued from the soil. However, the adults were abundant everywhere about cabbage fields during the periods mentioned. In 1911 the situation was very different. The first brood of adults emerged as usual. The second brood was marked by the appearance in cages of a few individuals between June 30 and July 6. No adults emerged in the laboratory between this date and the first of September. During this period adults were very scarce in the field. A few of our first-brood pupæ gave out flies between August 31 and September 9, but adults were still very scarce in the field and continued so until the 23d of September. However, they were conspicuous in cabbage fields from the above date until October 8. The third brood appeared so late that many of the adults, eggs and larvæ were destroyed by the cold.

[1] U. S. Ent. Bul. 16:24.

[2] U. S. Ent. Cir. 70:11.

To sum up, there were three effective broods of this insect in 1909 while during the summer of 1911 there was only one brood of insects present in sufficient numbers to be of economic importance. In western New York there are two periods each year when adults can be found about cabbage plants—in the spring, and in the fall. The spring adults come largely from the autumn brood of larvæ, though some flies are from delayed pupæ of the first and second generation of the previous season. The adults found in the autumn are from both first and second brood pupæ.

PRESIDENT GLENN W. HERRICK: Is there any discussion?

MR. T. J. HEADLEE: I should like to ask to what general cause the speaker ascribes this retardation.

MR. W. J. SCHOENE: After observing this insect for eight seasons, we have decided that the insect thrives best in a cold moist climate. The normal summer weather in Western New York is unfavorable to the species and, like some other insects, it remains dormant during the summer period.

MR. T. J. HEADLEE: I would like to ask whether moisture plays a part.

MR. W. J. SCHOENE: Moisture and temperature are very closely related and it is difficult to separate the influence of these conditions. Judging from some experiments out of doors, moisture had little to do in causing this delay and certainly has no effect after the larva pupates.

MR. W. C. O'KANE: This question of delay of individuals brings to mind the life-history of the apple maggot: We found a part of the individuals of that species leaving the pupal stage the second summer instead of the first summer. These irregularities occurred with groups of individuals, all of which so far as human measurements could determine, had the same physical surroundings. This appeared to be a characteristic of the species, as much a part of its nature as any of its obvious physical characteristics. In effect it provided against the serious results to the species that would otherwise follow non-fruiting of apple trees in large areas.

MR. T. J. HEADLEE: It seems probable from the results of the work in other biological lines that activities of an organism incident to an inherited physical or chemical structure are initated by stimuli arising from its environment and that these stimuli can be found and measured.

Regarding the impracticability of separating the effects of temperature and moisture, I desire to say that my experience indicates that the operation is one which requires proper machinery.

Mr. H. A. Gossard: In some cases I have had them carrying over until the third year where normally their development takes place in one, with the temperature and moisture conditions practically identical. Why they should carry over except for the propagation of the species is more than I can say—why a certain number carry over until a third year rather than come out the first and second year.

Mr. T. J. Headlee: It seems to me that we are making the mistake of assuming that temperature and moisture are the only important variables in the insect environment. As a matter of fact temperature and moisture are only two of a number of factors, and the fact that insects show differences in behavior when subjected to exactly the same temperature and moisture is no reason to conclude that the stimuli which initated the activities resulting in these differences can not be found and measured. We must remember that variation in light, barometric pressure, and various chemical stimuli have not been taken into consideration.

President Glenn W. Herrick: We will now listen to the next paper, by Mr. Geo. A. Dean.

THE HESSIAN FLY TRAIN

By Geo. A. Dean, *Entomologist, Kansas State Agricultural Experiment Station*

Since its first appearance in Kansas as an important factor in wheat production, the Hessian fly has alternately disappeared and reappeared. During the forty-four years of its known presence in the state it has produced seven different outbreaks, the last and the greatest of which destroyed not less than fifteen million bushels of the wheat of the 1915 crop. Believing that not only the attention of the farmers could best be called to the seriousness of the infestation, but also that more interest could be created in the control methods and that a larger number of wheat-growers could be reached within a short time, the Kansas Agricultural College decided to request the Santa Fé Railway Company, which had a large mileage in the infested districts, to run a Hessian fly train. In previous years a number of special institute trains had been run by the Santa Fé and the other principal railway lines in the state, but to operate an exclusive insect train was a new departure. However, the Santa Fé, which has always stood ready to coöperate with the College and Experiment Station, granted the request.

A chart of the infested districts was furnished the Dean of the Extension Division who met with the officials of the Santa Fé and prepared a schedule consisting of sixty-two stops. It was left entirely with the College to decide as to the best time to run the train and it

was felt that, inasmuch as the methods of control of the fly should begin as soon as possible after harvest, the best and most opportune time for the train would be the week just before the beginning of harvest.

The train consisted of a baggage car, two modern steel day coaches, each with a seating capacity of eighty-eight persons, which were used for lecture cars, and a private car, consisting of parlor and observation, dining and sleeping compartments. It was understood at the beginning that the train was to be an exclusive Hessian fly train and thus it was advertised as the Hessian Fly Special, operated by the Kansas State Agricultural College in coöperation with the Santa Fé. The speakers consisted of three entomologists of the Agricultural College, one entomologist of the United States Department of Agriculture, the head of the Department of Agronomy, the Superintendent of Farmers' Institutes, of the College, and one county demonstration agent. In addition to the lectures, the company consisted of the agricultural agent of the Santa Fé, the publicity agent of the Santa Fé, the publicity agent of the College, and representatives of some of the principal newspapers and farm publications. The divisional superintendents and roadmasters accompanied the train over their respective divisions of the road.

Addresses were made at all of the sixty-two places scheduled. In fact, at nearly all the places the attendance was such as to require two speakers and, on several occasions, it required a third speaker to accommodate the large crowd. If the attendance did not exceed two hundred, the two speakers took care of them in the lecture cars, but where the crowd was over two hundred the overflow was taken in the waiting room of the depot, where a speaker was provided. Where there was not an opportunity for the insect train to stop, a lecturer was dropped off to hold a meeting at the depot or an up-town place. Later the man would be picked up by one of the regular trains and left at a station where the Hessian Fly Special was scheduled to stop. Or a man would be sent ahead on a regular train to hold a meeting and would later be picked up when the Special came through. In a few cases speakers were taken to neighboring towns in automobiles. During the entire trip, every speaker on the train gave practically the same Hessian Fly talk. The entomologists and the agronomist of the College prepared the speech, copies of which were furnished not only to the speakers, but also to all the railroad officials and publicity men who accompanied the train. The publicity men prepared beforehand all the articles to be used by the newspapers in the places where addresses were made. In other words, every address given and every newspaper article published had just one message and that was the

Hessian fly special; McPherson, attendance 286

Hessian fly special; Stafford, 76 autos, 17 makes

Hessian fly special; Anthony, attendance 186

seriousness of the infestation and what should be done to protect the crop of the next year. It is the opinion of the writer that much of the success of the Hessian fly train and the good accomplished were due to the fact that all departments and all persons concerned were together and that nothing was said or done but what met with the approval and recommendation of every one. The fact that the very methods advocated for the control of the fly were in keeping with the very methods recommended by the Agronomy Department and which the progressive and successful wheat-growers knew should be practiced for maximum yields, appealed to the better judgment of even the most skeptical ones. The time allowed for each stop was about forty minutes. The speakers usually arranged for a few minutes' discussion before closing the meeting. Specimen cases, charts, and illustrated material were used in nearly all lectures. As the men left the lecture cars or the waiting room they were given circulars on the Hessian fly and the preparation of the seed bed for wheat. The Hessian fly circular was printed primarily for the occasion. It was simply a timely article emphasizing the methods of control and closing with a brief life history of the fly.

In nearly all cases large crowds met the Hessian Fly Special and the total attendance for the week was appproximately seven thousand. The farmers came with a desire to learn of better methods of farming which would reduce the loss from the Hessian fly. A remarkable interest was taken in what the lecturers had to say. At Stafford, Kansas, for example, 317 farmers met the train, and after the cars were filled an overflow meeting was held in the station. Three men were giving the Hessian Fly talk at the same time. There were seventy-six motor cars, representing seventeen different companies, parked near the station.

Mr. Frank Jarrell, the publicity agent for the Santa Fé, at the close of the week, said "it is beyond doubt one of the most successful institute trains ever operated by my company. The vitally interesting thing to me was the interest in better farming, shown by the men who met the train. The very evident wish which these men have shown to learn of Hessian fly control indicates a very hopeful future for Kansas agriculture, for it shows that there is a more general belief than ever in scientific agriculture, which, after all, is nothing more nor less than business farming."

President Glenn W. Herrick: It seems to me that it will be well to defer discussion until we have the paper by Mr. Gossard which follows closely the same lines.

COUNTY COÖPERATION TO REDUCE HESSIAN FLY INJURY

By H. A. Gossard, *Wooster, Ohio*

Our first effort in Ohio to completely organize the farmers, in a definite territory, to act as a unit in choosing the date for seeding wheat, was made the past fall. Since our success in inducing almost every farmer in a whole county to coöperate with us was unexpected, especially so, since our effort was concentrated on one township only, it may be worth while to describe the method followed.

The first steps toward organizing were taken by a few farmers of Elizabeth Township, Miami County, where the crop had been partially destroyed by the fly for several consecutive seasons. These requested the aid of their County Agent, M. C. Thomas, who was superintendent of the Miami County Experiment Farm, and he, in turn, requested my help in the movement. To enlist interest a meeting was arranged for at one of the villages of the township. Three or four of the most successful farmers of the township were put on the program to give fifteen-minute talks on various agricultural topics which they were specially qualified to discuss. This insured a crowd drawn from all parts of the township. I was invited to discuss the Hessian fly for a half hour, after which an organization was made, one man being appointed in each school district to induce his neighbors to sign a pledge to await the advice of the Station Entomologist and the County Agent before seeding. I think the pledging feature was not altogether successfully worked, nor do I consider it either a necessary or even a desirable part of such a campaign. Most farmers are willing to wait for any reasonable length of time for a signal to sow, but nearly all will balk at binding themselves to await the decision of a man who is personally somewhat of a stranger to them, and who might, to their minds, turn out to be an impracticable visionary. These school-district committeemen were of great use, however, in solidifying sentiment, distributing literature, etc.

My next step was to write to Professors Dean and Haseman, both of whom I knew to have had some experience with this coöperative plan of seeding, and obtain from them a statement of results. I also requested the names of county agents who had had experience with the work, and of farmers who had grown wheat under the plan. Three of the Kansas county agents wrote me, at Professor Dean's request, giving me their working plans and results. Eight or ten Kansas farmers also responded to my appeal for a statement of their experience. These letters from the farmers proved very useful, since a farmer will

sometimes accept the testimony of a fellow farmer more quickly than he will that of a professional entomologist or of a county agent. Multiple copies of all these letters were made and put in the hands of the county agent, and were given to some of the committeemen. Part of these were published in the local newspapers and the county agent published reports in the county papers of all public meetings.

However, the clinching factor, which rendered all this publicity work effective and influenced all the farmers of the county to fall into line without any organized solicitation, outside of Elizabeth township, was the installation of a breeding cage and the keeping of an egg-laying record at the County Experiment Farm. Had the farmers thought we were merely guessing at the date when the flies had gone, some of them would doubtless have concluded that they could do just as good a job at that, as an entomologist one hundred miles or more away; but when they realized that we had a definite method for determining when the brood was past *in their own county, under the conditions of 1915*, all were willing to wait for any reasonable length of time to learn our results; in fact, they were afraid to disregard them.

The breeding cage was simply a wooden box two or three feet long, about two feet wide and perhaps sixteen or eighteen inches high, without any bottom and a small hole in the middle of the top, over which a lantern globe was placed and covered with cheesecloth. Stubble and top soil, containing puparia in abundance, was collected from a plot badly infested the preceding season, dampened, and put into the cage September 14. This, I attended to personally, and the next morning gave to the county agent, Mr. Eastwood, who had succeeded Mr. Thomas, instructions for making the count and differentiating the fly with a magnifying glass from the other flies appearing in the cage. A daily record of the hatch was thenceforward kept. He was also taught to recognize the eggs on the wheat blades, and a few days later he marked 100 wheat plants, located at intervals down a suitable drill row, by putting hog-nose rings about them. All eggs were removed from the blades of these plants by rubbing them off with the finger, and the next day and each succeeding day, thereafter, the eggs were counted and then removed. The egg-laying record will show a maximum rate of egg-laying in the field a few days after the maximum emergence of flies in the cage. When both records show that the crest of the brood is well passed, and weather conditions for the season have been normal, or without a marked deficiency of moisture, it is usually best to recommend seeding, since the wheat will not be up and inviting to the flies for ten days or two weeks after it is sown, and by that time practically all of the flies will have disappeared.

We planned at first to publish daily, in the county papers, the record of the hatch and of egg-laying, to insure control of the more hasty farmers, but Mr. Eastwood judged this to be unnecessary, and so the record was not published until September 27, when I advised that the signal be given to seed. Mr. Eastwood was able to learn of only a few fields in the county that had been sown at that time. Nearly all of the seeding was done between October 1 and October 20 and during the fall developed no fly. The prospects for a good crop, wholly free from the fly over the whole county, would be perfect were it not for the numerous puparia which have developed in volunteer wheat, scattered through the clover fields, many of which have not even been pastured. Puparia can be found quite plentifully even in rather closely grazed clover fields.

A similar plan was followed in Clermont County, but, owing to a later beginning, was not so generally successful. However, County Agent Herron expressed the belief that a great majority of his farmers had awaited his advice, and that in another year the coöperation could be made practically unanimous. Very similar results were reached in one of the townships of Greene County, adjoining Miami, the unofficial management there awaiting the advice of Mr. Eastwood, because they had no county agent, nor any county farm of their own, on which to conduct the breeding tests.

Coöperative sowing in Ohio is bound to be only partially successful during droughty years, because of the flies issuing so tardily and irregularly from the stubble fields, seeded to clover, which cannot be plowed under; and where the seeding has been timed to give perfect success, the final harvest will be somewhat doubtful in all years, unless we can separate the production of wheat and clover.

President Glenn W. Herrick: Is there any discussion of these two papers?

Secretary A. F. Burgess: One point in Mr. Dean's paper which struck me very forcibly was that all these entomologists, agriculturists and newspaper men told the same story. That is one of the places where our entomological work and extension work frequently falls down—too many cooks. The arrangement of having all the lecturers tell the same story and the newspapers give the same report is a wonderful thing. It is something that should be copied in other endeavors of the same kind. A train that goes out for the purpose of distributing information should distribute information that does not contradict.

President Glenn W. Herrick: I have been impressed with the value of these two papers as illustrative of effective and successful

methods of putting entomological information before the farmer. This is a point where many of us fail. We get lots of information on a certain problem, publish it and then often send it to the wrong men who throw it into the waste basket or allow it to lie on dusty shelves unread and unused.

MR. F. M. WEBSTER: In 1891 Dr. C. V. Riley attempted to introduce a European parasite of the Hessian fly. It was placed in the field but little has been heard concerning it up to the present time. The facts concerning its introduction and recovery are given in the following paper by Mr. W. R. McConnell.

SUMMARY OF FACTS ABOUT THE INTRODUCTION OF PLEUROTROPIS EPIGONUS WALK

By W. R. McCONNELL

The species was originally described under the name *Entedon epigonus* Walker, and apparently is the same as *Semiotellus nigripes* Lindeman, as Dr. Riley compared specimens with Walker's types. (Forbes, *Insect Life*, 1892, 73.) The species is now placed in the genus *Pleurotropis*.

INTRODUCTION INTO AMERICA

1891—Riley received infested puparia from Mr. Fred Enock, of London, England, during the spring of that year.

This infested material was distributed to Forbes in Illinois, Cook in Michigan (Agricultural College), and Fletcher in Canada (Ottawa). (Forbes, *Insect Life*, V, 1892, 73; Riley, *Insect Life*, 1893, 133–4.)

No report from Cook and Fletcher, as far as I can find.

Forbes (*Insect Life*, V, 1892, 73) reported rearing adults from the original material in a small enclosed plat experiment, but up to August 15, 1892, had recovered no specimens from fields in which material was distributed. No further statement regarding the success of Forbes' experiments has been found.

1894—Material from Enock placed in field at Fredericktown, Md., and on farm of C. Morgan Eldridge at Cecilton, Md. (Howard, *Insect Life*, VI, 1894, p. 375.) (Fredericktown must be the Frederick of today.)

No further report from the Fredericktown introduction.

At Cecilton, Md., Ashmead succeeded in sweeping up one ♂ during May of the next year. (Howard, *Insect Life*, VII, 1895, 414–5.)

There seems to be no further records until our rearings at Hagerstown began in 1915.

In the following table is given the record of our rearings at the Hagerstown Laboratory:

Locality	No. of Specimens Reared	Collector
Hagerstown, Md.	14	McConnell and Myers
Andersonburg, Pa.	1	Myers
Warfordsburg, Pa.	1	Myers
Montoursville, Pa.	1	Myers
Ford City, Pa.	1	McConnell
Greenville, Pa.	1	McConnell
Total	19 specimens	

All of the localities except the last two are east of the Allegheny Mountains. Ford City, Pa., is on the Allegheny River, and Greenville is on the western edge of Pennsylvania.

We know practically nothing of its life-history, as I have never succeeded in inducing it to oviposit. Adults have emerged in cages from April to June inclusive and from September to December inclusive. Most of the specimens reared were males.

Importance

Riley stated that it was introduced because it was more abundant in England and far more beneficial than any of our native species. Enock was probably his authority for conditions in England. His statement for this country seems very doubtful, in view of the scarcity of the species. It may not be adapted to the climate, and again it may become very abundant during a widespread outbreak of the Hessian fly. The latter point of view is probably more nearly correct, since it seems to be able to maintain itself over periods when the host is scarce, in spite of the predominance of males.

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Hagerstown, Md., December 22, 1915.

PRESIDENT GLENN W. HERRICK: The next paper on the program is by R. R. Parker of Montana. As the author is not present the paper will be read by J. R. Parker.

DISPERSAL OF MUSCA DOMESTICA LINNÆUS UNDER CITY CONDITIONS

By RALPH R. PARKER, *Bozeman, Mont.*

(Not received in time for publication in this issue)

PRESIDENT GLENN W. HERRICK: Is there any remark or discussion?

MR. MAX KISLINK, JR.: I have been working on dispersion of the house-fly for the Bureau of Entomology. At the Animal Industry Farm at Bethesda, Md., we liberated from the 30th of June to September 10, 200 colored flies. All were liberated from about the same point on this farm. We bred these in cages from a lot of maggots taken from pig manure.

The method of coloring was with colored chalk and marking freshly emerged flies, not more than a day old. First we put traps within 500 yards from the point we liberated the flies and caught a good many in that way. Then we increased the distance. We also made rounds among the residents and whenever they saw a colored fly they would swat it. Some people who were not notified of it thought the flies were carriers of a certain kind of spotted fever. The results of the summer showed that the flight spread out over an area of one and a quarter miles. In the experiment I noted that the flies did not go in any particular direction with the wind. In fact I have often noticed the flies going against the wind.

PRESIDENT GLENN W. HERRICK: Did you put the chalk on their wings or on their bodies?

MR. MAX KISLINK, JR.: As soon as the flies emerged we let them out of the breeding cages into a trap. Then we put the flies into paper bags heavily chalked, shook them up and when they were let loose there was quite a cloud of color.

PRESIDENT GLENN W. HERRICK: For the past three years I have been spending a part of the summer on Cranberry Lake in the Adirondacks, one and one-eighth miles from the village of Cranberry Lake. There are no animals on that side of the lake but toward the latter part of the summer we are troubled with house-flies. There are no breeding places for them and they must come from the village one and one-eighth miles across the lake in a diagonal direction. I see no

other place where they can breed. They would in this case have to fly continuously across the lake.

Mr. T. J. Headlee: It was noted in England where flies had come from five miles away.

President Glenn W. Herrick: The next paper will be by Mr. Joseph H. Merrill.

LIFE-HISTORY AND HABITS OF TWO NEW NEMATODES PARASITIC ON INSECTS

By Joseph H. Merrill, *Manhattan, Kans.*

(Withdrawn for publication elsewhere)

President Glenn W. Herrick: It is interesting to find that there are some nematode forms that seem to be of some use in life.

I did not understand Mr. Merrill to say whether they actually killed the insects.

Mr. J. H. Merrill: A tent was placed around the trunk of an elm tree so that all emerging insects might be secured for breeding purposes. There were 121 *Saperda tridentata* which emerged from this tree and were placed in breeding cages, but in no instance did any of these insects deposit eggs. Not only was the vitality of the insects lowered but their natural functions were so interfered with that eggs did not even start to develop within their bodies. The death rate, due to nematode parasitism, was 100 per cent. Several experiments were carried on by placing termites in soil known to contain nematodes. In twelve days all of the termites had died, due to this nematode parasitism.

Mr. Don C. Mote: I would like to inquire whether these nematodes are truly parasitic. I take it from the paper that Mr. Merrill was able to rear them from the egg to the adult stage in cultures. This fact would seem to indicate that they are not necessarily dependent upon taking up their abode in the insects' intestines for their development. Generally nematode parasites attain a certain point in this development outside the host beyond which they cannot go unless they reach their normal habitat within their host.

Mr. J. H. Merrill: These nematodes were found to be parasitic on *Saperda tridentata* and *Leucotermes lucifugus*. The nematodes found in *S. tridentata* were fed in cultures on the macerated bodies of insects, while those found in the termites were fed exclusively on termites as we could easily secure a plentiful supply of these insects.

Mr. Don C. Mote: At what time during the developmental stage did infestation occur?

MR. J. H. MERRILL: How and when the nematodes gain entrance into the insects are two questions that are yet to be solved. As the nematodes were found in the intestines of *S. tridentata* it is possible that the nematode eggs may have been taken in with the food. As the nematode in the termites were found in the head and mouth cavity, these may have entered while the worms were still young. Although they could enter when quite small, they could not complete their development within the termite.

PRESIDENT GLENN W. HERRICK: Any more questions concerning this paper? If not we will pass to the next paper by Mr. J. W. Chapman and R. W. Glaser.

FURTHER STUDIES ON WILT OF GIPSY MOTH CATERPILLARS[1]

By J. W. CHAPMAN and R. W. GLASER

INTRODUCTION

During the past two summers (1914–1915) certain questions in connection with wilt of gipsy moth caterpillars have begun to clarify. The published experimental results obtained during the summer of 1913, while helpful in interpreting many of the phenomena encountered in this interesting problem, nevertheless left much in doubt. Our efforts were renewed during the summer of 1914 with the hope of verifying all of our previous experiments (1913) and of solving some of the questions towards which we had begun to assume a sceptical attitude. Many interesting matters were forcibly impressed upon us during the course of this study which extended over two seasons. The results obtained in 1914 were discouraging although instructive. In 1915, however, we not only obtained data harmonizing with those of 1913, but surpassing our expectations by yielding new and interesting results. This work also clearly revealed the inadequacy of some of our methods.

In order that other investigators interested in the polyhedral diseases of insects may be spared many of the tedious difficulties which we encountered we present our work historically, and will attempt to give an account of the methods which must be pursued in order to ensure dependable results. This method of procedure will also have the advantage of placing our new results in a proper light.

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[1] Contribution from the U. S. Bureau of Entomology in coöperation with the Bussey Institution of Harvard University. (Bussey Institution No. 110.)

Summary of Our Previous Work

The results obtained by our previous studies may be summarized as follows:

1. The wilt of gipsy moth caterpillers is a true infectious disease distributed over the entire territory infested by the gipsy moth.

2. Epidemics of the disease occur only in localities heavily infested by the gipsy moth.

3. Climatic conditions appear to bear an important relation to wilt in the field.

4. The disease is more prevalent among older than among younger caterpillars, but the latter also die of wilt in the field.

5. No diagnosis of wilt is valid unless polyhedra are demonstrated microscopically.

6. There is no record of the occurrence of wilt in the gipsy moth in America prior to 1900.

7. Minute dancing granules may be observed in wet smears.

8. Polyhedra are probably reaction bodies belonging to the highly differentiated albumins, the nucleoproteids.

9. The pathology of wilt does not vary with the age of the caterpillars.

10. The polyhedra originate in the nuclei of the tracheal matrix, hypodermal, fat, and blood cells.

11. The nuclei of the tracheal matrix and blood cells seem to be the first tissue nuclei affected.

12. Many minute violently dancing granules are found in the pathological nuclei of fresh tissue.

13. Giemsa's stain demonstrates many little granules in the nuclei of diseased tissue sections.

14. The alimentary canal seems to be the last organ in the body to disintegrate.

15. Two types of blood corpuscles exist in normal hæmolymph.

16. Two types of pathological blood corpuscles exist in diseased caterpillars.

17. The blood is a fairly reliable index of a caterpillar's condition.

18. The blood test is impracticable for large experimental series.

19. Bacteria are not etiologically related to wilt.

20. The virus of wilt is filterable with difficulty.

21. Such a filtrate is free from bacteria and polyhedral bodies.

22. Caterpillars that have died from infection with filtered virus are flaccid, completely disintegrated, and full of polyhedra.

23. Minute dancing granules were observed in the Berkefeld filtrates. These may be identical with certain granules observed in smears and tissue nuclei (sub. 7, 12, and 13) and may be etiologically significant.

24. The incubation period of wilt varies, and temperature at times seems to bear an important relation to this variation.

25. A large number of caterpillars used in the experiments died of disturbances in their normal physiological activities.

26. The success of wilt infection experiments is absolutely dependent upon attention to seemingly insignificant details.

27. Genetic immunity of certain individuals is probable.

28. Active immunization with sublethal doses is possible.

29. The polyhedral bodies may be stages of the filterable virus, but as yet no evidence to substantiate this view has been produced.

30. Infection naturally takes place through the mouth by means of the food.

31. There is no evidence that the wind is an important factor in distributing the disease.

32. Some of the imported parasites may be important factors in aiding the dispersion of wilt.

33. Although probable, there is no definite evidence as yet that wilt is transmitted from one generation to another.

Problems Requiring Further Investigation

From a review of our work during 1913 it seemed apparent that many wilt problems needed further investigation and verification. For this reason we concentrated our work upon the following questions:

(a) Can we obtain further evidence in order to substantiate our view that wilt is a true infectious disease?

(b) Can we produce further evidence that wilt is caused by a minute filterable organism?

(c) If wilt is caused by a filterable virus can we obtain some idea of its size?

(d) Has wilt a definite period elapsing between inoculation and death?

(e) What influence do climatic conditions (temperature and humidity) have on the length of this period?

(f) Does immunity towards wilt exist in certain members of the gipsy moth race?

(g) Is wilt transmitted from one generation to the next through the egg?

Difficulties Encountered in 1914

In order more lucidly to illustrate the satisfactory methods devised during the summer of 1915 we would like to present five out of fifteen experiments performed during the summer of 1914. The gipsy moth caterpillars used for these experiments were collected in the field while in the third and fourth instars from localities where no wilt had been noticed up to the time of the collection. The animals were

taken to the laboratory, and isolated from one another in autoclaved pasteboard or sterile tin boxes. Thus by isolation, all animals that harbored the disease and died before being used for experimental purposes were prevented from infecting others. This precaution was found necessary for the reason that it is impossible to determine during the early stages of the disease, whether or not a caterpillar is free from wilt infection. Of course Escherich's blood test method for eliminating chronic cases might have been used, but Glaser and Chapman (1913) and Glaser (1915) have shown that the blood test is impracticable for large experimental series.

Caterpillars dead from wilt were emulsified with sterile water. This material (amounting to about 100 c.c.) was filtered through cotton and later through paper. The filtrate thus obtained was passed through a Berkefeld Grade "N" filter by the use of a vacuum of approximately 28 inches. This Berkefeld filtrate was used for the infection experiments. Of course, the filtrate was tested for its bacterial sterility by plating on ordinary nutrient media. If the proper technical precautions are taken the filtrate obtained will be free from bacteria and polyhedral bodies.

The caterpillars were infected by holding the animals with their ventral side up. By means of a sterile eye dropper a drop of the filtrate was then placed directly over the mandibles. By exercising sufficient patience the animals can be made to drink the drop or even two or three large drops. It must be borne in mind that caterpillars will not drink prior to moulting, so it is important to obtain them after moulting or two or three days previous to this act. Moreover, caterpillars which have recently fed are unwilling to drink and therefore it is best to starve them for 24 hours before attempting an infection.

Every caterpillar in our experiments was infected with the same amount of the virus. Suffice it to say, that we prepared the virus in the same way for each experiment, and further attempted to have conditions as constant as possible.

Table I gives the results obtained in the first experiment. Twenty-five caterpillars were infected with the Berkefeld "N" filtrate and 25 controls were infected with the same filtrate sterilized by autoclaving for 20 minutes. Eighteen caterpillars died of wilt in the experiment and 19 in the controls. One individual escaped; one died of another cause (possibly bacterial infection), and 11 moths were obtained. Table II is self-explanatory. Tables III and IV represent similar experiments with the exception that the material was passed through the finer Grade "W" Berkefeld filter. By an examination of Tables I and II it will be seen that the deaths due to wilt in the controls exceed those in the experiments. In Table III the deaths in the experi-

ments exceed those in the controls by two. In Table IV the deaths in the experiments exceed those in the controls by 15. It was absolutely impossible to come to any conclusions on the results based on the above experiments. Table V represents an experiment in which 25 animals were infected with fresh, undiluted and unfiltered gipsy moth wilt virus. Twenty-five controls accompanied this experiment. As can be seen the deaths in the controls exceeded those in the experiments by six. Altogether fifteen experiments were performed and the results were all very similar to those outlined above. Can such discouraging results find an explanation, and how can they be made to harmonize with those obtained in 1913? The only feasible explanation which occurred to us was that many of the caterpillars used in our experiments in 1914 were chronically infected with wilt before being collected and that this accounted for the high mortality in the controls. Why some of the animals infected with the unsterilized virus survived and produced moths can possibly be explained by the suggestions offered by Glaser and Chapman (1913) and Glaser (1915). In short it seems very likely that many individuals are naturally immune towards wilt. In the discussion of the Berkefeld filtration experiments of 1913 it was further pointed out, that the wilt virus is difficult to filter on account of the abundance of cellular débris, pigment granules, hairs and polyhedral bodies. A film very soon becomes deposited on the outside of the Berkefeld candle and of course this retards filtration. In order partially to overcome this retardation, the virus was diluted to about 100 c.c. of sterile water and filtered through a fine grade of paper prior to filtration through the candle. As is well known, however, the albuminous material, polyhedral bodies, etc., easily pass through filter paper so that it is practically impossible to obtain material for the Berkefeld filter which will not deposit a film on the candle. Absorption of material into the interior of the candle necessarily also must retard the filtration. Naturally, the old candles must be frequently replaced by sterile new ones even during the course of one filtration.

As stated previously, the results obtained in 1914 were gravely at variance with those of 1913. Evidently we were fortunate in collecting healthy material in 1913, but our 1914 results clearly demonstrated that our chance method of obtaining healthy material ended disasterously. Another method had to be devised.

Origin of Material for the 1915 Experiments

If further experimental progress was to be made, it was thought absolutely necessary to raise a stock of caterpillars free from wilt infection or at least a stock in which the wilt mortality was reduced to a

minimum. After producing such a wilt-free stock, we could then rely upon individuals from such a stock for experimental purposes and the results would be significant. During the season of 1915 we raised several sets of caterpillars from eggs. In some sets or cultures no wilt mortality occurred throughout the entire season; in most of the other cultures wilt appeared, but the mortality was low. How certain individuals in these latter cultures became infected is open to several explanations, the most probable of which would seem to be that wilt is transmitted from one generation to another through the egg. Chronic carriers of the previous generation may resist death, pupate, transform and transmit the disease, as is the case with pébrine, to certain individuals of the next generation. Some members of this second generation become susceptible and die. That carelessness was responsible for the deaths in those cultures where wilt appeared spontaneously seems highly improbable for the reason that every conceivable bacteriological precaution was taken. We even went so far as to import daily the food for the animals from a territory which had never harbored gipsy moth caterpillars. The foliage before being picked was further examined for the presence of other lepidopterous larvæ. This precaution was thought to be necessary for the reason that Chapman and Glaser (1915) found wilt prevalent amongst ten of our native species of lepidoptera and the possibility of food contamination is very great.

In 1915 two sets of eggs were hatched. One set had its origin from moths that emerged from the control experiments the previous year (1914). The other set was kindly given us by Professor Richard Goldschmidt, who for several years has been investigating certain genetical questions in connection with the gipsy moth. Some of these eggs were derived from a pure Japanese race procured by Professor Goldschmidt from Ogi, Japan; others were derived from crosses between Japanese races with a race from Germany and one from Fiume, Hungary. The caterpillars from this second set of eggs were very easily distinguished from our introduced American race, by their peculiar coloring and pattern. Professor Goldschmidt informed us that he had had very little disease in his cultures the previous year, so we thought his material ought to prove very instructive.

Altogether a great many cultures were cared for, both American and foreign. These cultures represented our stock from which we took animals whenever they were needed for experimental purposes. Some of the animals were immediately removed from the stock on hatching and isolated, others were treated in bulk. At the beginning of the season, while the caterpillars were still in the second stage, many individuals died of wilt in three American cultures. These cultures

were quickly discarded for fear that the infection might spread to the remaining individuals.

Animals needed for an experiment were taken from a particular stock culture. The remaining individuals comprising this stock were kept under close observation throughout the season *i. e.*, the number of deaths and the number of moths which emerged were recorded. Thus in most cases, we were able to determine the health of a particular culture. Needless to say, no deaths in stock or experiment were attributed to wilt unless all the gross and microscopic symptoms were typical. (See Glaser, *Journal of Agricultural Research*, Vol. IV, No. 2, p. 104.)

Simple and Passage Infections

The following experiments were performed in order to prove whether or not wilt is a true infectious disease. All caterpillars used for an experiment were taken from a particular stock and isolated in separate, small, round tin boxes measuring three-fourths inches in depth and two and one-half inches in diameter. Such tin boxes were found far superior to the pasteboard boxes used during previous seasons. By keeping the lid closed the proper humidity conditions are obtained and the food remains fresh for two or three days if not eaten. The caterpillars also moult regularly in these tin boxes and they seem not to suffer in the least from their confinement. Lastly, the tin boxes can be easily sterilized by boiling water and can be used over again repeatedly.

The stock animals were nearly all raised in glass fruit jars measuring about three and one-half inches in height and in diameter. By screwing on the tin tops, the proper humidity conditions could likewise be obtained. If the humidity increased sufficiently so that drops of water formed on the glass, a little dry sand put into the bottom of each jar soon absorbed the excess moisture.

Table VI gives the results of the first experiment. Twenty fifth stage foreign *dispar* caterpillars were isolated, ten for the experiment and ten for the controls. Caterpillars which died of wilt were ground up in a motar with sufficient sterile water to facilitate the process. This liquid was strained through cheesecloth and then diluted to 40 c.c. with sterile water. The solution was next filtered through paper in a Buchner filter by using a slight suction. Ten caterpillars were fed from an eye dropper (method of feeding described on page 152) with the Buchner filtrate and ten controls, fed with the same filtrate sterilized by autoclaving, accompanied the series. Eight caterpillars died of typical wilt in the experiment and no controls succumbed. Two controls died of an "other cause." Two moths in the experiments and eight moths in the checks emerged. In the stock culture of 240

from which the animals were derived, 1¼ per cent died spontaneously of wilt and 78 per cent of "other causes."

Tables VII and VIII represent experiments similar to the one presented on Table VI with the exceptions that fourth stage American caterpillars were used in experiment VII and Japanese third stage animals in experiment VIII.

Table IX represents an experiment performed with American fourth stage caterpillars. Five animals were used in the experiments and five in the controls. Not a single animal died from wilt.

Tables X and XI represent passage infections. A caterpillar which died in one of the previous infection experiments was ground up and diluted to 10 c.c. with sterile water. This material was strained through cotton, filtered through paper in a Buchner filter, and fed to foreign fifth stage individuals represented on Table X. Twelve individuals were fed with the Buchner filtrate; 12 were fed with this filtrate autoclaved and 33 untreated caterpillars accompanied the series. The results can be gathered by consulting the Table.

Table XI represents the next passage. A caterpillar that died in the previous experiment was used. The material was treated in the same way, *i. e.*, ground up, diluted to 10 c.c. and filtered. Fifth stage foreign caterpillars were used.

Discussion of the Infection Experiments

The following data derived from a comparative study of the mortality tables are worthy of discussion: The number of caterpillars which died of wilt in the experiments and checks; the relation between the percentage of wilt mortality in the stock cultures and the percentage of wilt in the checks; the number of caterpillars which died of "other causes" in the experiments and checks; the relation between the percentage of "other cause" mortality in the stock cultures and the percentage of deaths due to that cause in the experiments and checks; the number of moths obtained in the experiments.

In the tables the wilt mortality of the experiments equals 68 per cent; in the checks 4 per cent. How can we explain the 4 per cent wilt in the checks? By comparing the wilt mortality in the checks with the wilt mortality in the stock culture in each table, we find that the condition of the stock usually explains the wilt mortality in the checks. Thus in Table VI none of the checks died of wilt and the wilt mortality in the stock was very low (1¼ per cent). In Table VII we have two cases of wilt in the checks and the mortality in the stock is rather high (9 per cent). In Table VIII one check died of wilt and the mortality in the stock is high (11 per cent). In Table IX no wilt is recorded and none in the stock. In Table X none is recorded in the

checks and none in the stock. In Table XI one case of wilt is recorded in the checks and none in the stock. The explanation offered to account for the 4 per cent check mortality is based on the above data, namely, when the stock wilt mortality is low or zero, the checks which are derived from such stock are likely to be healthy; when the stock wilt mortality is high, some of the checks which are derived from such stock are likely to be diseased. Table XI seems to be a slight exception to this rule. In this experiment no wilt is recorded in the stock, but one in the checks. It must be borne in mind, however, that the number of this stock culture was rather small and it is really unfair to base a health estimate on it. Of course, this one check may not have been chronically infected before being used. It may have contracted the disease subsequently by accidental infection, but this seems unlikely.

Under the heading died of "other causes" are grouped all of those animals that showed none of the gross and microscopic symptoms of wilt. Caterpillars which succumbed to this "other cause" death were usually in the fourth or fifth stage. They frequently hung by their prolegs in the typical wilt fashion, but their skin was tough and did not rupture easily as is the case with typical wilted individuals. On dissection such individuals proved to be practically free from body fluids, in contradistinction to the deliquescent state of wilted animals. In many cases the organs and tissues were almost shrunken beyond recognition due to the loss of blood and body fluids. No polyhedra were ever found in such animals, but smears from the intestine revealed countless Saccromycetes and Micrococci. Sections through these caterpillars failed to reveal the above mentioned microörganisms in any organ excepting the intestine. The Saccromycete and a Micrococcus were isolated from animals which died of this disease and other healthy ones were infected with these pure cultures. We failed to reproduce the disease with either microörganism. It might be well to mention that the Saccromycete grows very readily on bean and potato agar, and the Micrococcus flourishes on beef infusion and on beef extract agar.

A very interesting fact was noticed in all of the stock cultures and experimental animals. Nearly all of the individuals which died of the "other cause" death and which revealed the Saccromycete and Micrococci microscopically and culturally, were derived from the foreign eggs given us by Professor Goldschmidt. Very few American caterpillars could be found which yielded the above named microörganisms. The few found probably became infected from the foreign stock. By comparing the tables representing American with those representing foreign animals, and further by comparing the percentage of "other

cause" deaths in the stock cultures with the same deaths in the experimental animals, actual experiments, checks and untreated individuals, the facts to which we have here called attention stand out very vividly. (Compare Tables VI, VIII, X and XI with Tables VII and IX.)

Professor Goldschmidt experienced a high mortality in some of his Japanese gipsy moth cultures. We had the opportunity to examine many of his dead animals and found that the percentage of deaths due to the "other cause" was very much greater than the percentage of wilt mortality.

So far as the "other cause" mortality is concerned, the following facts are clear:

(1) The "other cause" mortality discussed in this article is not at all comparable to the mortality similarly designated by Glaser and Chapman in 1913. In 1913 it was due to low humidity; in this case probably due to one or more microörganisms.

(2) We believe that this "other cause" mortality is a specific disease which has no direct relation to wilt.

(3) This "other cause" mortality was never found during previous seasons in our American laboratory or field animals.

(4) It appeared for the first time this year (1915) in our foreign cultures and later spread to two or three American cultures.

(5) This new disease appears only during the later stages of the caterpillars (fourth and fifth stages).

By comparing Tables VI, VII, IX and X it will be seen that from one to five moths were obtained in nearly all of the actual infection experiments. There can be no doubt that the caterpillars partook of the virus for we were very persistent in seeing that they actually drank. Therefore, we offer two explanations: first, that certain individuals among gipsy moth caterpillars are immune to wilt. We have obtained eggs from such individuals and it will be interesting to note during the next season whether this immunity is transmitted to any of the next generation. Second, that certain individuals after inoculation become chronically diseased, but are nevertheless capable of undergoing metamorphosis. If this is the case wilt might be transmitted from one generation to another through the egg. The rearing of individuals from such eggs ought to throw much light on the subject.

Berkefeld Filtrate Experiments

Glaser and Chapman (1913) showed that bacteria in the ordinary sense of the word are not etiologically related to wilt, but that the evidence is very great in favor of the view that wilt is caused by a filterable virus.

The following experiments are offered as further proof for our view. Tables XII and XIII represent two experiments which duplicate one another in every detail.

Wilted material was ground up with sterile water and strained through cheesecloth. The liquid was then filtered through paper and equalled 70 c.c. This was next filtered through a Berkefeld "N" candle by gravity. Platings were made of the filtrate and since no bacteria grew it was considered sterile for ordinary forms. A portion of this same filtrate was centrifuged electrically and the bottom sediment examined microscopically. No bacteria or polyhedral bodies could be detected in fresh and stained smears. The animals used for these two experiments were all in the fourth stage and came from an American stock. They were, furthermore, all derived from the same egg cluster. Thirty-two animals were fed, by means of an eye dropper, with the Berkefeld "N" filtrate; 28 with the filtrate sterilized by autoclaving and 20 untreated individuals accompanied this series. In one experiment, Table XII, nine out of 32 animals infected with the unsterilized virus died of wilt. Moths were obtained from all the rest. In the other experiment, Table XIII, four out of 32 animals infected with the unsterilized virus died of wilt. The remaining individuals all transformed. Table XIV represents another similar experiment with slight variations. Fifth stage American caterpillars were used. The wilted material after preparation equalled 25 c.c. This was diluted to 100 c.c. and filtered through a Berkefeld "N" candle by means of a vacuum of about 27 inches. Ten animals were fed with the filtrate and ten with the filtrate sterilized by autoclaving. Four out of the 10 animals infected with the unsterilized virus died of wilt; three in the experiment and two in the checks died of "another cause" and moths were obtained from the remainder. Of course, no death was diagnosed as wilt unless all the gross and microscopic symptoms were typical.

By comparing the Berkefeld experiments with the simple infection experiments, one is at once impressed with the small number of deaths among the infected animals (23 per cent) in the former against 68 per cent in the latter. Of course, immunity may account for a number of the moths, but the difference between the two sets of experiments is too great for the immunity theory to account for all. This difference between Berkefeld and simple infection experiments was also noticed in 1913, and in 1914, and we offer the explanation presented on page 153 (absorption by candle and film deposition). Significant in these Berkefeld experiments is the fact that none of the checks died of wilt. As can be seen from the tables (XII, XIII and XIV), the condition of the stock was responsible for these gratifying results.

Pasteur-Chamberland Filtrate Experiments

Since our experiments seem to demonstrate that the wilt virus is capable of passage through Berkefeld candles it was thought imperative to ascertain whether or not the virus could be passed through something finer, namely, through Pasteur-Chamberland filters. For this reason the two following experiments (Tables XV and XVI) were performed. The virus was prepared in the usual way and equalled 60 c.c. This was passed through a Berkefeld "N" filter (vacuum of 27 inches) after which the resulting filtrate was passed through a Pasteur-Chamberland "F" filter (vacuum of 27 inches). Fifth stage foreign caterpillars were used in both experiments and the animals were infected by the pipette method. Tables XV and XVI are self-explanatory. Suffice it to say, that not a single animal died of wilt in either the experiments or checks. These two experiments seem to demonstrate that none of the virus is capable of passage through the Pasteur-Chamberland "F" filter. In other words, the size of the organism concerned in wilt lies somewhere between the size of the Berkefeld and Pasteur-Chamberland filter pores. Of course, some of the virus may have passed through, but was not sufficient to gain a foothold on account of a natural immunity of the animals. This, however, is pure speculation at present.

Is There any Relation between Sacbrood and Wilt?

In 1913 White discovered a disease in bees caused by a filterable virus, which he named Sacbrood for the reason that the dead larvæ when removed from their cells have the appearance of a small closed sac. The main difference between Sacbrood and wilt, however, seems to consist in the fact that polyhedral bodies have never been found by White in cases of Sacbrood. Of course, this fact need not exclude the possibility of the identity of the two diseases, for the bee larval tissue reaction towards the disease may be entirely different from the caterpillar tissue reaction. Polyhedral bodies may not be formed when the virus invades bee larvæ although formed when the same virus gains entrance to the caterpillar body.

Through the kindness of Dr. G. F. White, we obtained some Sacbrood material. At the same time we sent Dr. White some wilt material so that he could perform the reciprocal infection, *i. e.*, infect bee larvæ with the wilt virus. None of Dr. White's experimental bee larvæ developed Sacbrood or wilt as it is known in caterpillars. Tables XVII and XVIII represent two experiments accompanied by controls, in which gipsy moth caterpillars were infected with Sacbrood. As can be seen none of the animals so treated succumbed to wilt. From these experiments performed by us in coöperation with Dr. White, we con- hat wilt and Sacbrood are two distinct diseases.

Period from Infection to Death

In wilt a definite period elapses between the time of inoculation by feeding and death. This period varies slightly depending on the dosage, but is fairly constant in a certain class of experiments in which the dosages are constant. Tables XIX and XX graphically illustrate what happened in our simple and Berkefeld infection experiments. Table XIX represents the simple infections. Each square along the ordinate represents the greatest number of caterpillars that died on a particular day; the abscissa represents the number of days covered by the experiments. The first deaths occurred 13 days and the last deaths 27 days after inoculation. The highest point in the mortality is reached 18 days after inoculation. The mean for the entire simple infection experiments is 20 days. Table XX represents the Berkefeld infections. In this series the first death occurred 15 days and the last 29 days after inoculation. The highest point in the mortality is reached 23 days after inoculation. The mean for the entire Berkefeld infection experiments is 23 days.

By comparing the simple infection Table (XIX) with the Berkefeld infection Table (XX), it will be seen that in general the time from inoculation to death in the Berkefeld experiments is longer than in the case of simple infections. This difference between the two sets of experiments is due to differences in the concentration of the doses of the virus administered. In the Berkefeld experiments, as previously mentioned (p. 153), dilution, absorption, and film deposition play important rôles in decreasing the concentration of the virus and hence one would expect a longer period to elapse before the disease proves fatal. Table XXI represents Tables XIX and XX combined. The mean for both sets of experiments is 21 days.

Daily humidity and temperature records were kept during the entire experimental season by means of self-recording instruments for the purpose of determining whether or not these climatic factors had any influence in shortening or lengthening the period from inoculation to death. We have very carefully compared all of our records with the wilt mortality occurring in our experiments, but we have been absolutely unable to find any correlation between temperature and wilt or humidity and wilt or between both climatic factors and wilt.

On the basis of this failure to find any correlation (1915) between climatic conditions and wilt in our insectary, we would not like to exclude such a possible influence. Our records for the entire season show that the temperature and humidity were fairly constant. No extremes were reached in our insectary which was a subterranean greenhouse, so we feel obliged to continue these climatic observations in connection with wilt for another season or two before making any final statement.

Summary

(1) The chance method for obtaining healthy experimental material is absolutely worthless on account of chronic carriers.

(2) By selection a stock of caterpillars can be produced in which spontaneous wilt mortality is reduced to a minimum.

(3) Wilt is a true infectious disease.

(4) The virus of wilt is filterable through Berkefeld "N" candles.

(5) Caterpillars that have died from infection with the filtered virus are flaccid, completely disintegrated, and full of polyhedra.

(6) Microscopic examinations of the bottom sediment of centrifuged Berkefeld filtrates and platings of such filtrates show that they are sterile for bacteria.

(7) Berkefeld filtrates are free from polyhedral bodies.

(8) The nuclear inclusions called polyhedral bodies or polyhedra are by-products of the disease.

(9) We have been unable to force the wilt virus through Pasteur-Chamberland "F" filters.

(10) In our experiments the period from inoculation by feeding to death varied from 13 to 29 days. The mean for simple infections is 20 days; for Berkefeld infections 23 days. The mean for all the experiments is 21 days.

(11) An accurate record of the stock cultures is necessary for the interpretation of experimental results.

(12) Wilt seems to be transmitted from one generation to another through the egg.

(13) Certain individuals among gipsy moth caterpillars seem to be immune towards wilt.

(14) A new disease appeared in our foreign stock.

(15) A Saccromycete and a Micrococcus were isolated from cases of this new disease.

(16) The new disease appeared only during the later stages (fourth and fifth) and differ clinically and microscopically from wilt.

(17) Field observations have never revealed this new disease in our American race.

(18) Sacbrood and wilt are not identical.

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Table I. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "N"	18	1 escaped 1	5 { 3♂ 2♀
25	Berkefeld "N" autoclaved	19		6 { 3♂ 3♀

Table II. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "N"	6	2	12♀♀
20	Berkefeld "N" autoclaved	15	3	2♀♀

Table III. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Berkefeld "W"	8	1 escaped 2	14 { 11♂ 3♀
25	Berkefeld "W" autoclaved	6	2	17 { 14♂ 3♀

Table IV. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
20	Berkefeld "W"	17	2	1 ♀
20	Berkefeld "W" autoclaved	2	6	12 { 4♂ 8♀

Table V. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
25	Undiluted wilt	4	21	
25	Undiluted wilt autoclaved	10	1	14 {3♂ 11♀}

Table VI. Mortality among Foreign Gipsy Moth Caterpillars in Laboratory Experiments and in Stock Cultures

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" deaths in Stock of 240
10	Buchner filtrate	8		2 {1♂ 1♀}	1¼% wilt
10	Buchner filtrate autoclaved		2	8 {3♂ 5♀}	78% "other causes"

Table VII. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments and in Stock Cultures

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 31
10	Buchner filtrate	6		4 {2♂ 2♀}	9% wilt
10	Buchner filtrate autoclaved	2		8 ♀	0% "other causes"

Table VIII. Mortality among Foreign Gipsy Moth Caterpillars in Laboratory Experiments and in Stock Cultures

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 114
10	Buchner filtrate	5	5		11% wilt
10	Buchner filtrate autoclaved	1	4	5 {3♂ 2♀}	27% "other causes"

Table IX. Mortality among American Gipsy Moth Caterpillars in Laboratory Experiments and in Stock Cultures

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 162
5	Buchner filtrate		1	4♀	0% wilt
5	Buchner filtrate autoclaved			5♀	1¼% "other causes"

TABLE X. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	10	1	1 ♀	0% wilt
12	Buchner filtrate autoclaved		2	10 (9♂, 1♀)	20% "other causes"
33	Untreated		4	29 (14♂, 15♀)	

TABLE XI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 10
12	Buchner filtrate	11	1		0% wilt
12	Buchner filtrate autoclaved	1		11 (5♂, 6♀)	20% "other causes"
11	Untreated		4	7 (6♂, 1♀)	

TABLE XII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	9		23 (9♂, 14♀)	0% wilt
28	Berkefeld "N" autoclaved			28 (9♂, 19♀)	0% "other causes"
20	Untreated			20 (10♂, 10♀)	

TABLE XIII. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 42
32	Berkefeld "N"	4		28 (16♂, 12♀)	0% wilt
28	Berkefeld "N" autoclaved			28 (9♂, 19♀)	
20	Untreated			20 (4♂, 16♀)	0% "other causes"

TABLE XIV. MORTALITY AMONG AMERICAN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 30
10	Berkefeld "N"	4	3	3 {1♂, 2♀}	0% wilt
10	Berkefeld "N" autoclaved		2	8 ♀	No record of "other cause" percentage

TABLE XV. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock of 71
10	Pasteur-Chamberland "F"		1	9 {4♂, 5♀}	7% wilt
10	Pasteur-Chamberland "F" autoclaved		1	9 {2♂, 7♀}	17% "other causes"

TABLE XVI. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS AND IN STOCK CULTURES

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived	Percentage of Wilt and "Other Cause" Deaths in Stock
10	Pasteur-Chamberland "F"		1	9 {6♂, 3♀}	None left in stock
10	Pasteur-Chamberland "F" autoclaved		2	8 {3♂, 5♀}	No wilt in stock up to time caterpillars were used

TABLE XVII. MORTALITY AMONG FOREIGN GIPSY MOTH CATERPILLARS IN LABORATORY EXPERIMENTS

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
10	Sacbrood of Bees		2	8 {5♂, 3♀}
10	Sacbrood of Bees autoclaved		1	9 {4♂, 5♀}

Table XVIII. Mortality among Foreign Gipsy Moth Caterpillars in Laboratory Experiments

Number of Caterpillars	Treatment	Died of Wilt	Died of "Other Causes"	Lived
5	Sacbrood of Bees		3	2 {1♂ 1♀}
5	Sacbrood of Bees autoclaved................		2	3 {2♂ 1♀}

Table XIX. Simple Infections, Showing Period from Infection to Death.

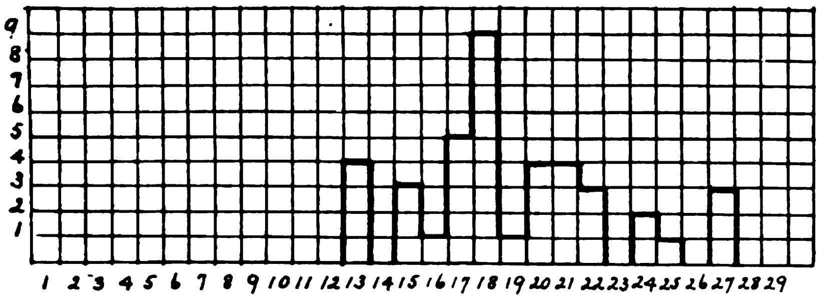


Table XX. Berkefeld Infections, Showing Period from Infection to Death.

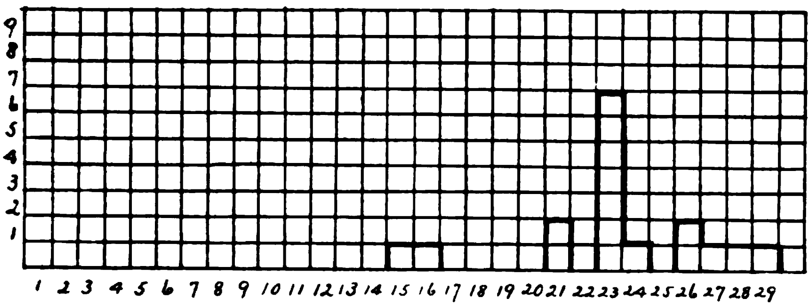
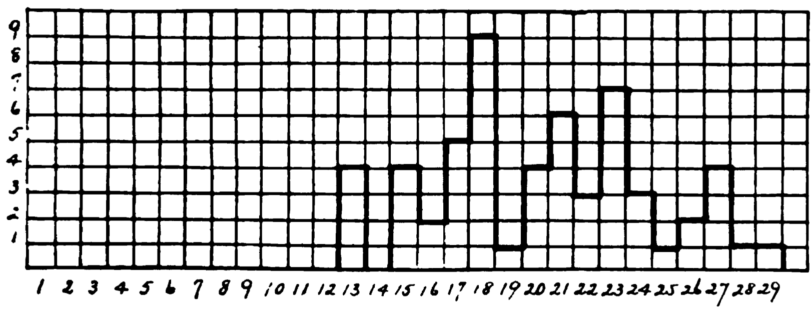


Table XXI. Total Infections, Showing Period from Infection to Death.



PRESIDENT GLENN W. HERRICK: Is there any discussion on this paper by Dr. Chapman?

MR. T. J. HEADLEE: Has this disease been tested on the insects as well as on their food? Has it been used on a large scale in the field as a spray on the trees so that it could be fed upon?

MR. J. W. CHAPMAN: Caterpillars have been subjected to "wilt" material in various ways. It has been applied to their skin, and to their food, as well as fed to them by means of a pipette as I mentioned in the paper.

There is evidence that infection can take place when "wilt" material is applied to the caterpillars' food but no evidence that it can take place when applied to the skin.

Our own work, so far, has been confined to the study of the etiology of this type of disease. Others have attempted to use the disease in a practical way but owing to the almost universal distribution of "wilt" they have been unable to determine whether the results obtained were due to the natural spread of disease or to artificial infection.

PRESIDENT GLENN W. HERRICK: Is there any data which shows whether this disease is the same as that prevalent in Europe. Has it been known for a number of years?

MR. J. W. CHAPMAN: As to whether it is the same disease we cannot definitely state but our experimental results indicate that it is.

SECRETARY A. F. BURGESS: I think we may have to change the name of this disease. The common usage in New England in the area infested by the gypsy moth, is the "wilt" disease. Wilt diseases of plants are common in green houses and to prevent confusion it may be necessary to call this a *polyhedral disease;* then there would be no confusion.

PRESIDENT GLENN W. HERRICK: If there is no further discussion, Dr. Aldrich would like to make an announcement just at this point.

MR. J. M. ALDRICH: I am working on the Oscinidæ of grains and grasses. The last authority who classified our North American species was Mr. Becker, of Germany, in 1912; he recognized in our fauna the important European species *Oscinis frit* and *pusilla,* and I have some of the material so determined by him, now in my collection. However, there appears to be a striking difference in habit between the American species and those of Europe, which raises a doubt in my mind as to the correctness of the identifications.

Oscinis frit was known by Linnæus, its describer, to live in the larval stage in the unripe kernel of barley: the Swedes called the spoiled kernels *frits,* which gave Linnæus the specific name.

Oscinis pusilla is widely known in Europe as the oat fly, and its larvæ attacks grains of oats likewise.

I have never heard of any such attack upon barley or oats in North America, and wish that my hearers would bear the matter in mind next summer and see if any such injury can be found. Our species mine in the stems of grains and grasses, but we seem to have none that feed in kernels of grain.

President Glenn W. Herrick: We have one more paper this afternoon which will be presented by Mr. Hunter.

RESULTS OF EXPERIMENTS ON THE USE OF CYANIDE OF POTASSIUM AS AN INSECTICIDE

By Walter Wellhouse, *University of Kansas, Lawrence, Kansas*

In view of the number of reports, mostly favorable,[1] which have been published recently regarding the efficiency of cyanide of potassium as an insecticide against borers and plant parasites, when injected into the tissues, it seemed desirable to carry on some experiments on this question in Kansas.

Accordingly, at the instance of Professor S. J. Hunter, of the University of Kansas, and under his direction, preliminary experiments to ascertain the effect of cyanide of potassium on plant tissues and on scale insects were begun March 13, 1915.

It was thought best to use first, tender house plants, on which the effects could be seen at once. Twenty-five coleus plants infested with mealy bugs (*Dactylopius*) were secured from a greenhouse. Fifteen of these coleus plants were treated with potassium cyanide, 98 per cent pure. With a sterilized needle an incision was made in the stem of each plant, a cyanide crystal weighing from one-half milligram to three milligrams was inserted into the incision, which was immediately sealed with paraffine. In from two to three hours later the tissues bordering the hole where the cyanide had been placed began to turn dark brown and within a couple of days the stem at this point was shrunken and bent. The tissues seemed to be cauterized by the cyanide. The mealy bugs continued to grow and multiply even on the very portion of the stem where the cyanide was injected. Several plants used as checks were punctured with the needle and the puncture covered with paraffine but no cyanide was used in them. They showed no signs of injury from the treatment.

Then we determined to try the experiment on trees infested with borers. A number of different species of trees on and near the campus were selected. The trees chosen were elm, apple, pear, plum, apricot, osage orange, ailanthus, willow and pine. Over fifty trees were used

[1] Science," Oct. 9, Dec. 11, 1914; Feb. 5, Feb. 26, 1915.

in the work. Holes varying from one to three inches deep were bored in the trunks with one-half-inch and three-eighths-inch augurs, at distances varying from a few inches to four feet above the ground. Charges of 98 per cent pure potassium cyanide, each weighing from one to ten grams, were placed in the holes and corks tightly driven into the holes. As checks, several trees were treated in exactly the same way, excepting that no cyanide was used in them. This work was done during the last of March and first of April. On May 10, the corks were removed and it was found that the cyanide had completely dissolved in the sap, no residue being present in the holes. A slight odor of cyanide seemed to be present, and the wood surrounding the interior of the holes was moist and dark brown in color. Most of the corks were replaced in the holes. On June 3, it was noted that the trees treated with cyanide seemed to have a darker, healthier foliage than their neighbors. The corks were again removed and the bark cut away from the holes in several trees. It was found that both the cambium and sapwood were dark and dry, both above and below the hole for several inches. This injury did not extend laterally from it and was just as deep as the hole. Beyond the inner end of the hole the injury had not extended inward.

On November 22, all of the trees were again examined, and the bark cut away farther from the holes. The results were quite uniform. The wood was blackened above and below the holes where cyanide had been inserted. No injury was found where no cyanide was used in the holes. A number of borers were taken alive from elm and plum trees within a few inches of the holes where cyanide had been placed. The blackened areas on trees which had been examined June 3 had increased to several times their length on that date. This black wood always occurred as a streak the width of the hole and followed the direction of the grain of the wood above and below the hole. In several cases the cambium and inner bark had dried and had been pushed out from the black streak and a callous growth was starting from both sides beneath the bark over the entire length of the streak.

This shows that the tree is injured only above and below the opening in which the cyanide is placed and that the healthy wood on both sides is attempting to heal the wound caused by the cyanide. No dead insects were found but in some of the holes left uncorked since June sow bugs were found to be breeding.

Dr. J. H. Merrill of the Kansas Agricultural College has been carrying on some experiments along this line. Professor Dean advises me that the results obtained were similar to those just given. The effects on the trees treated, as noted by both departments, was that the foliage ~~me a distinctly darker and richer green after the introduction of ~~anide.

1.

2.

3.

4.

POTASSIUM CYANIDE INJECTIONS

1, Coleus pierced but no KCN injected; 2, Cyanide injected and living Mealy Bug; 3, Dark streak in apple caused by KCN; 4, Living Elm Borers after KCN injection.

PRESIDENT GLENN W. HERRICK: I believe all this trouble began near Professor Kellogg's territory.

MR. V. L. KELLOGG: I might say that the stimulus may have come from Stanford University but not from the Stanford entomologists. A great many letters came to the Department of Entomology asking for information, but a professor of physics took up the subject on his own initiative.

SECRETARY A. F. BURGESS: I think it has been a long time since Professor Kellogg has attended one of our meetings and I am sure we are all pleased to see him here.

I hope he will take to the coast with him the best wishes of the Association to the entomologists of that region.

MR. V. L. KELLOGG: I thank you very sincerely.

MR. WM. MOORE: I was particularly interested in this paper as we carried out practically the same work last fall and published in *Science* the original discussion.

We found that the reason for the failure to kill the mealy bugs was due to the cyanide not traveling up the plant through vascular bundles but through the intercellular spaces. In trees it travelled through the old trachea. I think it went about 8 feet in one apple tree. We then cut down the tree and determined the cyanide by chemical test. In one tree we bored a number of holes and inserted little glass tubes containing distilled water. It was interesting to note that the cyanide happened to miss every one of these holes in the tree. It shows you really how much chance you would have with the wood-boring insects.

PRESIDENT GLENN W. HERRICK: No further discussion?

We will have a joint session tomorrow morning with the Entomological Society of America to hear the papers by Professor Webster and Dr. Howard.

Adjourned, 4.30

MORNING SESSION

Thursday, December 30, 1915, 10.00 a. m.

The Association met in a joint session with the Entomological Society of America, Prof. V. L. Kellogg, President of that association in the chair.

As previously arranged, the papers prepared by Prof. F. M. Webster and Dr. L. O. Howard were to be presented at this session. Owing to the sudden illness of Professor Webster his paper was read by Dr. E. P. Felt. (Withdrawn for publication elsewhere.)

Two papers were then presented by Dr. L. O. Howard.

ON THE HAWAIIAN WORK IN INTRODUCING BENEFICIAL INSECTS

By L. O. Howard

There have been several efforts in the past few years to bring together some account of the experiments in different parts of the world with the practical use of the natural enemies of injurious insects. Probably the first of these was contained in the writer's paper on "The Economic Status of Insects as a Class," the address of the retiring President of the Biological Society of Washington, January 18, 1899, afterwards published in *Science*, new series, IX, No. 216, pp. 233–247, February 17, 1899, and afterwards republished in the Annual Report of the Smithsonian Institution for 1898, pp. 551–569 (Washington, 1900). The second was probably the writer's paper presented before the Massachusetts Horticultural Society January 13, 1906, and published in the Transactions of that Society for 1906, Part I, pp. 11–19 (author's abstract, Boston, October, 1896).

In 1907 was published Paul Marchal's important paper entitled "Utilisation des Insectes Auxiliaires Entomophages dans la Lutte contre les Insectes nuisibles à l'Agriculture," which appeared in the *Annals* of the National Agronomical Institution (Superior School of Agriculture), Part II, Vol. VI of the Second Series, pp. 281–354. The writer translated this paper, and it was published in *Popular Science Monthly*, Vol. LXXII, April and May, 1908, pp. 352–370 and 406–419. In this admirable summary, Marchal mentioned the work of the importation of the natural enemies of the sugar cane leaf-hopper by the Sugar Planters' Association of Hawaii, but was apparently uninformed at that time as to the success or non-success of the work.

In the following year, 1908, Dr. F. Silvestri visited the United States and Hawaii, and in 1909 published in the *Bulletin* of the Society of Italian Agriculturists another important summary, included in his account of his investigations, under the title "Sguardo allo Stato attuale dell'Entomologia Agraria negli Stati-Uniti del Nord America e Ammæstramenti che possono derivarne per L'Agricoltura Italiana." A translation of a large portion of this will be found in the Hawaiian *Forester and Agriculturist* for August, 1909 (Vol. VII, No. 8). Having spent a month on the Hawaiian Islands in intimate association with the entomologists at the Sugar Planters' station, Silvestri was able to give a rather full account of the work done there, and praised it highly.

A later general summary of the world work of this kind will be found in the first 46 pages of Bulletin 91 of the Bureau of Entomology,

"The Importation into the United States of the Parasites of the Gipsy Moth and Brown-tail Moth: A Report of Progress with some Consideration of Previous and Concurrent Efforts of this Kind," by L. O. Howard and W. F. Fiske (Washington, 1911). In this account some space is devoted to the search for parasites of the sugar cane leaf-hoppers in Hawaii, with the final statement that "The practical results of these importations seem to have been excellent. There seems no doubt that the parasites have been the controlling factor in the reduction of the leaf-hoppers."

The latest to be published is the chapter entitled "Die biologische Bekämpfung," in K. Escherich's book, "Die angewandte Entomologie in den Vereinigten Staaten," published by Paul Parey in Berlin, 1913; but in this account the Hawaiian work is not mentioned.

The Hawaiians themselves have not bragged about their achievements. They have published bare statements of facts with technical descriptions of imported species, but have shown themselves aggrieved by statements made by Froggatt in his account of his journey around the world during which he spent a month on the islands and they have published, as just indicated, a translation of a large, part of Silvestri's commendatory paper. Recently, however, they have seemed to be more inclined to tell the world exactly what they have done and to welcome the favorable and even enthusiastic comment which must necessarily follow a widespread knowledge of their achievements. Mr. O. H. Swezey, for example, in an excellent, straightforward, and at the same time modest paper which he read before the meeting of the Association of Economic Entomologists at Berkeley, California, during the first week of last August (published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 8, No. 5, October, 1915), has put the entomologists of the world in possession of many new facts which were unknown to them before.

But still, enough has not yet been said, and the writer satisfied himself by a visit during August, last, to Oahu, by observation, and by interviews with the scientific men of the island and with the practical men of affairs, that Hawaii has seen a most extraordinary series of successful experiments in the introduction of beneficial insects which has in toto far excelled anything of the kind that has been done elsewhere in the world and which has resulted in an immense monetary saving. There can be no doubt of it.

THE SUGAR CANE LEAF-HOPPER AND ITS IMPORTED PARASITES

The sugar cane leaf-hopper of Hawaii (*Perkinsiella saccharicida* Kirkaldy) appears to have been introduced with seed from Australia about 1898.

It was first found harmful to sugar in 1902. It spread rapidly, and in 1903 damaged the crop to the extent of three millions of dollars. That year Kœbele came to the United States to look for parasites.

In 1904 Kœbele and Perkins went to Australia; got more than one hundred species of parasites of leaf-hoppers, and although failing with their first consignment sent in cold storage from Cairns, later shipments from Bundaberg were successful. They were reared in confinement and liberated in cane fields.

The year 1904 showed enormous loss from the leaf-hopper on many plantations. In 1906 certain of the parasites began to multiply very rapidly.

In 1907 one very large plantation, owned by the Hawaiian Agricultural Company, whose crop had dropped from 10,954 tons in 1904 to 1,620 tons in 1905 and to 826 tons in 1906, made the next year 11,630 tons almost entirely as the result of the parasite introduction.

Silvestri visited the islands in 1908 and reported with enthusiasm on the results of the introductions.

During August, last, the situation with regard to the sugar cane leaf-hopper on the island of Oahu was almost perfect. The canes were not damaged in any respect so far as I could see. The leaf-hoppers were still present, but in insignificant numbers; where they had oviposited their eggs were almost invariably parasitized either by Paranagrus or Ootetrastichus.

I was told that there is an occasional reviving of the leaf-hoppers in numbers, following the destruction of parasites by trash-burning, and that, at that time, on one large plantation on the island of Hawaii, 1,000 acres was so badly infested that a yield of only one-half a normal crop was expected; but these recrudescences are and probably will be fugitive.

No other leaf-hopper parasites were seen. Some of the parasites of the adults, notably Haplogonatopus (a Dryinid), I was informed, still exist on the islands.

The Sugar Cane Borer and its Parasites

The sugar cane weevil borer, *Rhabdocnemis (Sphenophorus) obscurus*, has been a pest on the islands for very many years.

After the success of the egg parasites of the leaf-hopper in 1904–5, the Planters' Association began to search for parasites of the weevil. F. Muir started on an exploring trip, and in 1908 found a Tachinid fly (*Ceromasia sphenophori* Villeneuve) at Amboina in the East Indies parasitizing a weevil infesting sago palms, sometimes destroying 90 per cent of the borers, the weevil being probably only a geographic variety of the sugar cane species.

During the summer of 1908 efforts were made to send this tachinid to Hawaii by means of a relay breeding station at Hong Kong, but failed. Later, in British New Guinea, Muir found the same tachinid destroying a borer in sugar cane, identical with the Hawaiian species, and destroying a high percentage. He succeeded in breeding it in cages. He was taken down with typhoid, and on arriving at Brisbane, Australia, was forced to go to a hospital. His parasite cages were sent on to Honolulu, but, wanting proper care, the parasites died.

After his recovery he met J. C. Kershaw, an entomologist whom he had previously met at Macao, China, at Brisbane in January, 1910. Kershaw prepared cages at Moresby, North Queensland, and Muir went to New Guinea where he collected puparia of the tachinid and sent them to Kershaw. The latter placed these in cages containing the prepared sugar canes containing numerous borer larvæ.

Muir continued to send puparia until Kershaw had the tachinids satisfactorily breeding, when he joined him, and, taking fresh puparia from the cages, went to Fiji where another breeding station was established. When this was successfully done, Kershaw abandoned the cages in Queensland and went to Fiji with more puparia. When he arrived, Muir went to Honolulu with tachinids, leaving Kershaw in Fiji where he remained a few more weeks and then came on to Honolulu with additional parasites.

Muir arrived in Honolulu with living parasites in August, 1910, and Kershaw arrived the following month. Part of the parasites were liberated and others retained in breeding cages.

The breeding continued for two years in the cages; the colonies were liberated on sugar plantations as rapidly as they were available. They bred continuously, each generation requiring about six weeks, and there were about six generations a year.

After six months they were found established and increasing in plantations where the first liberations were made, and in a year spread to all parts of these plantations, sometimes over a distance of five miles.

In 1914 Swezey reported (Journal of Economic Entomology, December 14, 1914) that they were established almost entirely throughout the sugar cane districts of the islands.

Prior to the introduction of parasites, hand collecting had been practiced on some plantations. On one plantation, in 1913, 27,010 ounces were collected; in 1914, on the same plantation, only 3,440 ounces were collected, showing a reduction of over 87 per cent.

In August, 1915, I found the borer rare on Oahu. In no case did I find a living larva. Mr. Swezey and Mr. Osborn found for me a number of burrows, but in every case when they were opened the larva had been destroyed and the puparia of the tachinid were present.

As the result of this importation, there has been a very great increase in the sugar yield per acre. The gain runs into the hundreds of thousands of dollars.

The adult tachinid places her eggs at openings in the rind of the cane where the borer larvæ feeding inside have come to the surface. The maggots find the borer larvæ in the channels, penetrate the body and kill the host when it is about ready to pupate. From one to a dozen maggots may thrive in one borer larva, but one is sufficient to kill it. The puparia are found in the fibrous cocoon made by the full-grown borer larva. The flies on issuing make their way through the cocoon and out of the cane through the hole which the borer larva had previously made.

The Mediterranean Fruit-Fly and its Introduced Parasites

The Mediterranean fruit-fly has been present in Hawaii since some time prior to 1910, and has practically stopped the growing of fruit except pineapples and bananas, although some sound mangoes and alligator pears are still raised.

On account of the occurrence of enormous quantities of wild guava bushes all over the mountains, the extermination of the fly or even its great reduction in numbers seems to be impossible. The destruction of the fallen fruit afforded little relief. Poisoning experiments, although somewhat successful, could not control, on account of the enormous wild supply.

Silvestri, by his favorable report on the work of the Sugar Planters' Association in the introduction of parasites of the leaf-hopper, achieved the good will and admiration of the Hawaiian people, notably Mr. W. M. Giffard, Chairman of the Entomological Committee of the Sugar Planters' Association and President of the Hawaiian Board of Agriculture and Forestry. He therefore asked Silvestri to search for parasites of the fruit-fly and to introduce them into Hawaii. Silvestri started July 25, 1912, and visited the Canary Islands, Senegal, French Guinea, Southern Nigeria, Gold Coast, Dahomey, Congo, Angola, and South Africa; then, by way of Australia, he went to Honolulu, arriving May 16, 1913.

He brought with him from West Africa, having continuously reared them through the journey, 300 specimens of *Galesus silvestrii* Kieffer, 500 specimens of *Dirhinus giffardi* Silvestri, 12 specimens of *Opius perproximus* Silvestri, 5 specimens of *Opius humilis* Silvestri, and 4 females and 3 males of *Diachasma tryoni* Cameron. The rearing of these was begun by Mr. D. T. Fullaway until September 30, and then by Mr. J. C. Bridwell from October 1 to December 31, 1913. It was found not very difficult to rear some of them in confinement. The

Galesus and the Dirhinus, both pupa-parasites and received in the greatest numbers, have not yet become established. They have been put out in quantity but have not been recovered in the open. Whether the character of the soil is the trouble, or whether they are all destroyed by the fire ant is a question.

The Braconids were discouraging from the start. *Opius perproximus* failed. *Opius humilis* and *Diachasma tryoni* were divided. Four females of Diachasma and three females of Opius were liberated in the district of Kona. Those retained in breeding cages were lost.

Now comes the extraordinary thing. From the insignificant number of seven females of the Diachasma and Opius liberated in Kona, both species have become established! Both are larva-parasites, and were rediscovered by Mr. Giffard and Doctor Back. An examination made by Back and Pemberton in the summer of 1914 indicates percentages of parasitism as high as 85 in larvæ from coffee berries grown in the Kona district, 97.8 per cent in larvæ from coffee berries at Lanihau and high percentages in other fruits at other places.

The Earlier Introductions

The earlier introductions of parasites and beneficial insects against injurious insects, made by Kœbele before the outbreak of the sugar cane leaf-hopper, have been rather fully considered in Mr. Swezey's paper and elsewhere. Very many of them undoubtedly did excellent work. In spite, however, of the large numbers of enemies of mealy-bugs that were introduced at that time, outbreaks are frequent though not serious; and, although efficient parasites were introduced for leaf-rollers and the latter are not now very injurious, outbreaks occasionally occur. This, however, is quite to be expected, and in any consideration of the value of imported parasites we must never expect extermination but a reduction to comparatively non-injurious numbers with an occasional increase to some extent.

In the case of none of these early introductions was there sufficient study made of the intimate biology of the species introduced, and in fact the most careful study should be made now of the intimate life-history of the recently introduced parasites, and especially of those which are still coming in from Mr. Fullaway. Some of this work I hope Mr. Timberlake will be able to do.

Just why they have been able to accomplish so much is at first glance rather hard to understand. As early as 1897 Mr. R. C. L. Perkins, writing in *Nature* (Vol. 55, No. 1430, March 25, 1897), and referring to the successes of the importations of many species by Kœbele for the purpose of destroying various crop pests, wrote as follows:

It becomes natural to ask why the success of the imported beneficial insects has been so pronounced here, while in other countries it has been attained in a comparatively small measure. The reason, I think, is sufficiently obvious. The same causes which have led to the rapid spread and excessive multiplication of injurious introductions, have operated equally on the beneficial ones that prey upon them. The remote position of the islands, and the consequently limited fauna, giving free scope for increase to new arrivals, the general absence of creatures injurious to the introduced beneficial species, and the equability of the climate, allowing of almost continual breeding, may well afford results which could hardly be attained elsewhere on the globe. The keen struggle for existence of continental lands is comparatively non-existent, and, so far as it exists, is rather brought about by the introduced fauna than by the native one.

In commenting upon Mr. Perkins's paper, the writer, in his address on "The Spread of Land Species by the Agency of Man," said: "Mr. Perkins's reasons are all good, but he has not mentioned one prime reason of success, and that is that the most successful of the imported species have come from another portion of the same great faunal region, while others have been received from the region most closely allied, viz. the oriental." This was in connection with a discussion as to the chances of acclimatization of insects brought from different life zones.

In connection with this discussion, by the way, I concluded: "It is on the degree of simplicity of its life—the degree of simplicity of its natural environment as a whole—that the capacity of a species for transportation and acclimatization, even in a parallel life zone, depends." Mr. H. S. Smith recently, in a letter in which he quotes this sentence, very aptly writes: "It seems to me that the degree of simplicity of the new environment is quite as important. If the species introduced into Hawaii had encountered the complex relation that *Apanteles fulvipes* did in New England, where it was attacked by eighteen different species of secondaries as well as several predators during the first generation, there might have been a different tale to tell!"

It must be pointed out in conclusion that while conditions in Hawaii are extremely favorable for the reasons which Dr. Perkins formulated so early in the game, the men in control of the work were fortunate in themselves in the first place, and in having Mr. Giffard among them, and fortunate in being able to financially support any promising measure; and were fortunate, also, in having Mr. Kœbele and Dr. Perkins at hand; and were fortunate later in being able to add to their forces such men as Swezey, Muir, Silvestri, and Osborn, and now Fullaway; and at the present moment Timberlake, with his admirable technique and broad knowledge, is on the Pacific on his way to take up parasite work under the combined auspices of the Sugar Planters' Association

and the Territorial Board of Agriculture. All the possible requirements for successful work have thus been filled, namely the most favorable climate (permitting continuous breeding throughout the year), the most favorable conditions of cultivation, a small number of crops, a restricted and simple fauna, a highly intelligent body of men in control, with plenty of means, and an altogether admirable force of scientifically trained employees. As the French would say, *Que vouliez vous encore?*

What we shall want later is a complete account of the whole work from Mr. Giffard or Dr. Perkins or Mr. Muir or Mr. Swezey. The work has been most notable and should have its written history available to all.

FURTHER NOTES ON PROSPALTELLA BERLESEI HOW.

By L. O. Howard

The little Aphelinine parasite known as *Prospaltella berlesei* has become a creature of much international and practical importance, and its name in various combinations, not only as a noun but as a verb as well, has made its entrance into the Italian and Spanish languages, and bids ultimately in these same combinations to enter the English language.

Originally found by Berlese in Florence, issuing from lilac twigs infested by *Diaspis pentagona* sent from Washington by Marlatt at the writer's request in May, 1906, this parasite was sent back to the writer in Washington, was found to be new, and was described by him as *Prospaltella berlesei* in an article on the parasites of *Diaspis pentagona* in *Redia*, Vol. III, part 2, and in the *Entomological News* for October, 1906, pp. 292–293. Sendings of parasitized scales from Washington to Florence were continued during 1906, 1907 and 1908.

Berlese's continuous success in rearing and colonizing this parasite on mulberry trees affected by the scale has been reported from time to time, notably in an article in the Journal of Economic Entomology for August, 1912, pp. 325–328, translated by the writer from a French abstract of Berlese's report drawn up by Dr. Caterina Samsonoff.

During the past year Professor Berlese has published in a long article in *Redia* (X, Parts 1 and 2, May 20, 1915, pp. 151–218) a summary account of the warfare in Italy against *Diaspis pentagona* which at the beginning of the present century threatened the extinction of the silk industry of Italy through the destruction of the mulberry, of the early laws enacted to enforce the mechanical and chemical fight

against it, of the introduction and spread of the Prospaltella and of its eminent success, until in 1914 a large part of Italy was relieved from the danger, the old laws for its treatment had been canceled, and quarantine on the part of France against Italy had been modified.

Thus the practical introduction and colonization of this Prospaltella in Italy by Berlese has proved to be one of the greatest of the successful efforts of this kind yet carried out.

Attracted by this Italian success, the Prospaltella has recently been introduced from Italy into Switzerland and Spain, and at an earlier date into Uruguay, Argentina, Peru, and Chile—in Uruguay and Argentina from both Italy and the United States, to be used against *D. pentagona;* and into Peru and Chile from the United States, to be used against other species of Diaspinæ. A certain amount of success has been achieved in the Argentine Republic and in Uruguay, and in the former country a national Prospaltella commission has been founded, under the Ministry of Agriculture, for the purpose of handling the dissemination of the parasites. It is entitled "Comision Nacional Para Propagar la Prospaltella Berlesei How.," and Señor F. A. Barrœlavena is the president.

In both Italy and Uruguay the Italian and Spanish equivalents of the verb *to Prospaltellize* and the noun *Prospaltellization* have apparently come into general use.

Berlese and Marlatt are probably correct in their belief that *Diaspis pentagona* is an indigene of tropical oriental countries. Marlatt writes concerning this species: [It] "is common to all eastern Asia, including Japan and the East Indies, and undoubtedly, from its wide distribution and local occurrence in most out-of-the-way districts, is a native of this region and has been spread about in times so remotely past as to be beyond determination. It is probably a tropical species which has worked northward until practically the whole region as far as Peking, China, and the north island of Japan has been covered." [1]

Unlike most Aphelinines, *Prospaltella berlesei* seems to be rather specifically connected with *Diaspis pentagona*, whereas most of the group may be reared from several Diaspine hosts. It is probable, therefore, that this parasite is also of oriental origin, and in fact the whole genus Prospaltella may very possibly be of tropical oriental origin. Of the twenty-two species which have been described, six have been described from the United States, five from Italy, two from Spain, one from Germany, one from Porto Rico, one from Peru, one from Hawaii, one from India, one from China, one from Java, and three from Australia, but it must be noted that all have been described within the past twenty years, and, as has been frequently pointed out, so great

[1] Bulletin 37, new series, Division of Entomology, p. 78.

has been the commercial carriage of Coccidæ upon plants imported from one country to another that it is no longer possible to ascertain the original country of the majority of the species, and naturally the same may be said for their parasites. In fact, as I have elsewhere pointed out,[1] the entire Aphelinine fauna of the United States was radically changed by these accidental importations in the twenty years between 1880 and 1900. *Prospaltella berlesei* occurs in Japan, as was ascertained by Berlese after its discovery in Italy from twigs sent from Washington. In Washington its host was first discovered about 1894. No effort was made to rear parasites from it until the lilac twigs bearing it were sent to Berlese in 1906, but the parasite may have come in from almost any part of the world, since plants were being brought to Washington from many points. The manner of the introduction of the scale in Washington is unknown, and there are no data for even a respectable theory. The same must be said of the parasite.

Berlese assumes that: "This species was imported to Washington by Marlatt without his knowledge with material gathered in the extreme east" (free translation). This assumption is purely theoretical, and, as a matter of fact, is groundless. I myself examined all the parasites reared from the Coccid material sent in by Marlatt, including that reared from *Diaspis pentagona* shipped as food for *Chilocorus similis*, and, as Marlatt has pointed out (loc. cit.), the only species reared from this scale were *Aphelinus fuscipennis* How. and *Aspidiotiphagus citrinus* (Craw.), the latter being the most numerous. There is no chance that the Prospaltella was unknowingly imported by Marlatt.

Professor Berlese is greatly to be congratulated on the successful outcome of his intelligent and perservering and arduous work in this great experiment, and it is a great satisfaction to the United States Department of Agriculture and to American workers generally that the United States was able to assist somewhat in return for the many courtesies shown to workers in the Department and in the country generally by Berlese and his Italian colleagues.

The joint session then adjourned. The Association of Economic Entomologists were then photographed on the front steps of the Botany and Zoölogy Building. They reconvened in another room and a paper was presented by Mr. J. R. Parker.

[1] *Bulletin de la Société entomologique de France*, 1911, No. 12, pp. 258–259.

THE WESTERN WHEAT APHIS (BRACHYCOLUS TRITICI GILL.)

By J. R. Parker, *Bozeman, Mont.*

Historical

The Western wheat aphis was originally described by Professor Gillette in *Entomological News* for December, 1911. Concerning it he remarks, "This is seemingly a rather rare species occurring upon grasses and has been taken several times by L. C. Bragg upon the leaves of blue stem (*Agropyron glaucum*) and upon wheat during the summer months in the vicinity of Fort Collins."

In Montana this insect first attracted attention in 1910 when reports came to the experiment station that a plant louse was destroying winter wheat in a few localities in Fergus County. An investigation of these reports brought out the fact that more injury was being done than we had believed a grain plant louse capable of doing. In one instance a grower who had 700 acres of wheat estimated his loss due to wheat aphis at 5,000 bushels. Another grower had 80 acres of winter wheat so badly injured that no attempt was made to harvest it.

Since 1910 the Western wheat aphis has become increasingly abundant in Fergus County and has appeared in injurious numbers in several other counties. During the past two seasons in Montana, with the exception of the army cutworm (*Chorizagrotis agrestis* Grote), it has ranked as the most destructive insect pest of winter wheat.

Since economic entomological literature contains no account of the Western wheat aphis, and because of the great economic importance of its host plant, this paper has been prepared to bring together some of the facts which have been learned about this new pest of wheat.

Description

Technical descriptions of the various forms of this species have been published by Professor Gillette in *Entomological News*, Volume XXII, pages 441–442. In this paper only a brief general description will be given.

The wingless viviparous female, which is the form most frequently seen, is peculiarly shaped, being unusually long and narrow for an aphid. It is about 2 millimeters in length, and .6 of a millimeter in width. The general color is a pale yellowish green, but this is generally hidden by a powdery white coating. The body appendages are all somewhat reduced: the cornicles can be seen only with the aid of a lens; the antennæ are less than half the length of the body and the legs are quite

Western wheat aphis: 1, Comparison of normal and infested plants; 2, Characteristic type of injury.

short. The peculiar long and narrow body with its covering of white powder will easily distinguish this form from other aphids commonly found upon wheat.

In the winged viviparous female the head, antennæ and thorax are black, while the abdomen is light green. The body is powdered with a white secretion, but to a less extent than in the wingless female. The body is also shorter, the length averaging about 1.5 millimeters. The cubital vein of the wing is twice forked. This form may be distinguished from other grain aphids by the cornicles, which are greatly reduced and appear only as mere rings slightly raised above the surface of the body.

The oviparous female is similar in appearance to the wingless viviparous female.

The male is wingless, only about half as long as the female, less densely clothed with white powder and is somewhat lighter in color.

The eggs are pale yellow when first laid, but soon change to green and after a few hours become shining black.

Character and Extent of Injury

Wheat plants infested with the wheat aphis have a characteristic appearance which is easily recognized after having once been seen. On small plants the first indication is a thickening and broadening of the leaf blade. Soon longitudinal, whitish stripes appear and these frequently become pinkish in the later stages. Leaves of infested plants in late fall and early spring have a fleshy and whitened appearance as compared with the slender dark green leaves of uninfested plants. One or two aphids hidden from sight and feeding in the yet unexpanded basal portion of the leaves are sufficient to bring about the characteristic appearance described above. These soon increase, however, and the entire upper surface of the leaves is frequently covered with lice. No curling of the leaves has been observed in the fall or early spring. Heavily infested plants make little or no growth and by midsummer are generally dead. Plants less heavily infested sometimes stool out and eventually send up a twisted central stem bearing a deformed head. A short time previous to heading, the leaves surrounding the central stem generally become tightly curled and as a result the head has difficulty in pushing up through them and very frequently forces its way through the side of the boot or sheath. The peculiar twisting of the terminal leaves which occurs in this stage is quite characteristic, the leaf twisting spirally in one direction for a short distance and then curling in the opposite direction. The deformed heads seldom reach a height of over ten inches from the ground and, as a rule, do not ripen any grain.

Wheat aphis injury is more commonly found in circular areas from 10 to 50 feet in diameter, distributed in an irregular manner about the field. In May these spots are noticeable because of the stunted and peculiar appearance of the small plants; in June many of the plants are wilting and yellowing, while a few are sending up curled stems bearing deformed heads; by midsummer practically all the wheat plants are dead and the area is covered with a growth of weeds. In some cases entire fields of wheat have been completely destroyed; such instances are not common, but are occurring more frequently each year.

Other Host Plants

Barley is the only grain crop besides wheat which thus far is known to be injured by the wheat aphis. Oats seem to be disliked and are not harmed even when growing in the midst of infested wheat.

Blue joint grass (*Agropyron occidentale* Scribn.), when growing in and around the edges of infested wheat fields, is always heavily infested and is probably the native host plant. However, an extended search for the wheat aphis upon blue joint grass some distance from infested grain fields has not as yet revealed it in such localities. Near infested wheat, the wheat aphis has also been found upon cheat (*Bromus secalinus* L.), spear grass (*Stipa comata* F. & R.) and timothy (*Phleum pratense* L.).

Seasonal History and Habits

The winter is passed in the egg stage upon fall seeded wheat, volunteer grain and grasses. The eggs hatch early in April and the resulting stem mothers become adults and begin producing young in about two weeks. About June 1, a few winged forms appear and fly to new host plants. By June 15, winged migrants are very plentiful and continue in increasing numbers until about July 1, when they begin to decrease in number. In Montana no winged forms have been seen after August 15, and it appears that the period of greatest activity in migration in normal seasons occurs from about June 15 to July 1. This period is of particular importance in relation to control measures. The winged migrants do not settle upon large plants even though they are green and succulent, but are apparently prompted by instinct to search out smaller plants which will afford food for a longer period. Summer fallowed fields plowed previous to June 15 and then allowed to grow up to grasses and volunteer grain offer the ideal conditions which the migrants are seeking. Scattering plants spring up and, having a large area from which to draw moisture, remain green and succulent until killed by heavy frosts in the fall. Upon such plants, wheat and blue stem primarily, the wheat aphis passes the summer.

During the hottest summer weather coccinellid and hymenopterous parasites greatly reduce their numbers, but as cold weather comes on the parasites lessen their activities and the aphids become so abundant that their host plants are overloaded, forcing the plant lice to migrate in search of fresh food. By this time the new crop of fall wheat is well started and again the migrants find the ideal conditions which they are seeking. Observations were made in infested grain fields during the first week of November of the present season, and, whenever an infested stool of volunteer wheat was found, the wingless lice could be seen crawling away from it in all directions. Thus one good-sized stool of volunteer grain will reinfest much of the new crop within a radius of 10 to 25 feet and sometimes to greater distances. It is a significant fact that, whenever an area in which the wheat has been destroyed by the wheat aphis is examined in the spring, the old dried volunteer plants from which the infestation started can always be found.

About October 15, true males and females are produced and egg-laying is carried on until very late in the fall. On December 2, 1914, wheat plants were seen which were covered with egg-laying females even though the thermometer had registered 11 degrees below zero in that vicinity on November 15. The eggs are deposited for the most part upon the leaf blade upon which the female is feeding, but are also placed upon dried stems and upon the soil. The old volunteer plants and bunches of blue joint have upon them the greatest number of eggs, but many are also laid upon the small fall wheat plants by the crawling migrants.

Control

Clean Tillage of Summer Fallowed Fields.—The life-history and habits as just discussed would naturally suggest clean tillage of summer fallowed wheat land as the most feasible method of control. That this is the right method may be emphasized by the statement that no wheat aphis injury has ever been found except on summer fallowed land where volunteer grain and grasses have been allowed to grow. Fall wheat on sod land in heavily infested localities has never been injured even when adjoining fields have been completely destroyed.

It is a very simple matter to advise that the wheat aphis can be completely controlled by keeping summer fallowed fields absolutely free from volunteer grain and grasses, but it is often a difficult and expensive proposition for the farmer to put the advice into practice. The ordinary method of procedure in the handling of summer fallowed wheat land in Montana is to plow in the spring and to follow with a varying number of diskings to kill vegetation and to conserve moisture.

But even if repeated cultivations are give with the ordinary disk harrow, some volunteer wheat and much blue joint grass is very likely to escape and only a few such plants are necessary to bring about an infestation of wheat aphis in localities where it is abundant. Moreover, in the most heavily infested districts of Fergus County, soil and climatic conditions are such that frequent diskings during the summer months are not desirable, for when the soil becomes finely pulverized it blows and drifts badly the following winter. Several of the less common methods of obtaining clean summer fallowed fields are, therefore, discussed with particular reference to their bearing on wheat aphis control.

Use of Special Tools.—It has already been said that the ordinary disk harrow allows some vegetation to escape. There are now on the market tools of the duck-foot cultivator type which are composed of sets of overlapping V-shaped knives which will cut all vegetation just below the surface of the soil. These are much more efficient than the disk as destroyers of vegetation, are of light draft and do not pulverize the soil as much as the disk harrow. They have the disadvantage of not working well in rocky ground.

The use of the hand hoe in destroying vegetation which has escaped the first diskings is practiced by some growers, who report it a cheaper and more thorough method than to continue the disking.

Late Plowing.—In discussing the wheat aphis with many growers, a surprisingly large number have remarked that fields plowed early, that is, in April and May and up to June 15, were severely injured, while nearby fields, plowed after June 15, were uninjured. One man started plowing on May 15, but at that time plowed only an area of a few rods wide around the field. On July 4, plowing was resumed and carried to a finish. The following spring the early plowed area was badly injured by the wheat aphis, while the late plowed area was practically uninjured. Such cases are easily explained. On the early plowed land volunteer grain and grasses have an opportunity to start up during the season of rainy weather that follows plowing, thus bringing about inviting conditions to the migrants which are flying in June and July. In late plowed fields all volunteer grains and grasses that have started during the rainy season are turned under and the field is left bare during the migration period.

Some growers disk the stubble early in the spring and then do not start plowing until after June 15. The disking has a tendency to hasten the germination of grains and weed seed and makes plowing easier.

Some of the most successful growers plow twice, a shallow plowing in early spring and a deeper plowing after June 15, well toward the close of the spring rains. Such fields are remarkably free from vol-

unteer grains and grasses and are said to give increased yields over once-plowed fields. No wheat aphis injury has ever been seen on double-plowed fields.

Late plowed fields can undoubtedly be kept free from vegetation with much less labor than early plowed fields and this practice, when it can be carried on without interfering with economic farm practices, is recommended in districts where the wheat aphis is abundant.

PASTURING.—Some farmers allow a small band of sheep or other stock to graze on summer fallowed land and where vegetation is kept down in this manner wheat aphis injury has not been noticed.

In November of the present year, an 80-acre field of winter wheat was seen which was so badly infested with wheat aphis that there seemed to be absolutely no hope of the crop maturing if left as it was. The field was everywhere dotted with clumps of volunteer wheat, from which females were migrating to the new crop, and already nearly every young wheat plant was infested with egg-laying females. A band of 1,500 sheep was turned into this field and in a short time had grazed off nearly all vegetation. Whether a new growth will be produced that will be free from wheat aphis remains to be seen, but it is certain that a great majority of the plant lice and their eggs have been destroyed and this method gives some promise in the handling of fields that are already badly infested.

CROPS THAT MAY BE SOWN ON GROUND WHERE GRAIN HAS BEEN DESTROYED BY THE WHEAT APHIS.—Wheat aphis injury generally appears early enough in the spring so that destroyed areas may be seeded to spring grains or other crops.

Spring wheat may be safely planted if infested wheat plants are first plowed under. This was tried in several fields during the past season and in no instance was the spring crop injured. Spring wheat and barley drilled in among infested plants have been badly injured and this practice is considered decidedly unsafe.

Probably the safest and easiest crop to put in on such land is oats upon which the wheat aphis has never been seen to feed. One grower whose 80-acre field of fall wheat was completely infested with aphis in the spring merely drilled in oats without previous preparation of the soil. The young oats grew side by side with the heavily infested wheat, but were never attacked and at harvest the crop yielded 50 bushels to the acre. By early summer all of the wheat in the field had been killed.

This concluded the reading of papers for the meeting and after the usual closing business session the meeting adjourned.

A. F. BURGESS, *Secretary.*

Proceedings of the Fifth Annual Meeting of the Section on Apiary Inspection

The Fifth Annual Meeting of Apiary Inspectors was called to order by the Chairman, Dr. E. F. Phillips, at the Southern Hotel, Columbus, Ohio, Monday evening, December 27, 1915.

The meeting showed the largest attendance of any yet held. This was undoubtedly due to the fact that it did not conflict with the meeting of any other section and was held at the hotel headquarters of the Association.

The principal things brought out in the address of the Chairman and in the other papers presented were fully discussed and led to the following action by the Section:

It was moved by Dr. Headlee and carried by vote, that it is the sense of this Section that the Association of Economic Entomologists admit apiary inspectors to associate membership. Dr. Headlee was appointed to confer with the Association on this matter.

A motion by Dr. Headlee was carried by vote that this Section go on record in favor of apiary inspection work being placed under central authority and under the direction of one having had a broad entomological training.

It was moved and carried by vote that the Section adopt the suggestion of the Chairman that inspectors report disease conditions of apiaries along state boundaries to Dr. E. F. Phillips at Washington.

Upon motion by Mr. Millen a committee was appointed to draw up a uniform system of reporting apiary inspections. Mr. Shaw, Professor Dean and Mr. Millen were appointed on this committee.

By vote of the Section, Dr. T. J. Headlee was recommended to the Association of Economic Entomologists for Chairman of the Section and Mr. N. E. Shaw was reëlected Secretary.

THE FUNCTION OF THE APIARY INSPECTION SECTION

By E. F. Phillips

It is obvious that the formation of a section in the Association of Economic Entomologists for consideration of the problems in apiary inspection was a long step toward the proper recognition of the place of beekeeping in economic entomology. If we look back only a few years we will realize how impracticable it would then have been to get together a group of the economic entomologists of the United States who had any interest in beekeeping.

For a society to undertake improvement in the apiary inspection service is a large problem, in spite of the fact that we all realize the need of improvement in many places. We can scarcely hope to correct such defects as may exist without in some way reaching the men at work in the field and I would therefore respectfully commend for your deliberation the best means of reaching these men. It is impossible to get all the inspectors and deputies together once a year for a conference because of the great distances to be traveled and the lack of funds to pay their expenses as an official trip. Furthermore, most of the men engaged in the work are not members of the Association of Economic Entomologists and many, not being trained entomologists, are not eligible to membership under the present requirements. It is a pertinent question whether the Association should assume to have a section for such a special phase of economic entomology without making a special requirement to fit that section. Theoretically, it may be admitted that the standards for admission should be kept high, practically, it is a pity for an organization to limit its usefulness by keeping out men who need the help that they might well get from the organization. There is also room for debate on the question whether an organization is strengthened by artificial barriers of admission or whether its entire strength does not lie in its usefulness. The associate list might profitably be increased, in so far as this section is concerned, to include all apiary inspectors who care to join.

It is not easy to say what is the greatest need in apiary inspection but, after having traveled with a number of the inspectors, I should incline to the view that a reduction in the waste of time and more system in the work are most needed. To spend too much time in helping the individual beekeeper and to visit longer than necessary is a too common fault. In fact, some inspectors do little more than to make a series of visits to the members of the beekeepers' association every year, thus giving time to men who scarcely need the inspector and depriving others of less opportunity. There is often much waste in flitting from place to place. There is little this section can do to put a stop to these unwise things except to give public utterance to a condemnation of the practice.

As is well known, the Bureau of Entomology has for several years advised placing the apiary inspection under some already existing office, usually with the State Entomologist. It can be stated without fear of successful contradiction that in states where there is a competent experienced supervisor, the results are vastly better than in states where the inspector is a free lance. One important consideration is the keeping of adequate inspection records and these will not be properly kept unless there is an established central office. Case

after case could be mentioned of earnest effort which has come to no permanent good because of lack of supervision. I commend to this section the desirability of definite public utterance on this question for the guidance of the appointing powers and state legislatures.

At a conference of apiary inspectors held at the invitation of Mr. Frank C. Pellett, Apiary Inspector for Iowa, in Keokuk, Iowa, on September 8, 1915, Mr. N. E. France of Wisconsin called attention to a lack of coöperation among inspectors of adjacent states and made certain suggestions for overcoming the deficiency. To bring this before the section I desire to present the question for consideration.

The brood diseases of bees do not respect state boundaries and it would be well for an inspector to know of cases of disease found in counties that adjoin his state. This could be done simply by correspondence between the inspectors but this probably will not be done in many cases unless some regular system is devised.

As the inspectors know, the Bureau of Entomology notifies the inspector when a sample of diseased brood is received from the territory under his supervision. If it is the wish of the inspectors, the Bureau will gladly extend this by receiving reports of inspection along state lines and notifying the adjoining inspector. This will be rather easily done in conjunction with our maps on the distribution of the diseases.

Possibly this will not give as much information as the inspectors would like to have and it may be considered desirable to devise some other method of giving the information. In any event it would seem desirable that the prevalence of the disease be indicated and not merely a notice sent of the existence of the disease.

It would probably be desirable to have records of all cases of disease kept in some central office but this is beyond the needs of the case in point.

There is need of greater publicity of the work of the apiary inspectors, if for no other purpose to stimulate interest in the control of disease. Such publicity would do much to point out any waste of funds and I would suggest the desirability of gathering together every year the records of inspection in all the states where this work is done. To give the number of apiaries visited, the number that are being visited for the second time that season, the number that have been visited previous seasons, the amount of disease found, the money expended, as a total and per colony, and all available data as to any reduction in the prevalence of disease would do much to point out deficiencies and to stimulate to better work. It would, in fact, be the application to inspection of the methods of modern efficiency. Such a summary might be prepared by the Secretary of this section and published in

tabular form in the JOURNAL OF ECONOMIC ENTOMOLOGY. There would be cases of injustice in comparing cost of inspection per colony and each inspector should be permitted to add a brief statement of any reasons which might exist for unusual expense. Under this heading, a preponderance of small apiaries or difficulties of travel might be stated. An inspector who had a hard time in explaining why it costs twenty-five cents or more per colony might be stimulated to inspect more the following year. Some inspectors do considerable extension work and there should be a careful estimate of this expense to be deducted from the regular inspection expense with a statement of the number of days spent in each kind of work. This might bring out the fact that in some cases the inspection is being neglected and the time spent on certain lines of extension work which the conditions do not justify.

It is perhaps impossible to make a definite statement as to what constitutes inspection of a colony or apiary. If an inspector goes into a region where little or no disease exists and visits an apiary of 100 colonies belonging to a good beekeeper, he may not open a single colony or he may examine a few weak ones. He may be justified in reporting no disease in the apiary but if he reports having inspected 100 colonies, his record for the year is not comparable with that of another inspector who must examine every colony. It might be well to make a record of the total number of colonies and of the number actually examined. In some cases this would perhaps give an entirely different complexion to the report. Such a distinction is entirely warranted as giving a basis for judging whether the inspector is doing all he should. Of course it is assumed that all the reports of inspection of individual apiaries are truthful, which assumption may stand until there is evidence to the contrary.

In presenting these points for your consideration it may be well to summarize briefly the points mentioned.

1. Extension of the influence of this section.

2. Reduction in the waste of time in inspection.

3. Declaration of the need of a central office for the state inspection service.

4. The need of information concerning disease in adjacent states.

5. Summary of records of various state inspection service for comparison as to cost per colony and general efficiency.

6. Definition as to what constitutes inspection.

These suggestions are made because, with the impossibility of central control, there will certainly be a waste of funds in places unless it can be remedied by publicity. In certain cases of waste that have come to my attention it is clear that the inspector is acting in ac-

cordance with his best judgment and in an earnest effort to help beekeepers. If this section can provide a safer basis for judgment it will be conferring a great benefit on beekeepers who are suffering from neglect.

SOME DIFFICULTIES IN GROSS DIAGNOSIS OF THE INFECTIOUS BROOD DISEASES OF BEES

By Arthur H. McCray, M. D., *Apicultural Assistant, Bureau of Entomology, U. S. Department of Agriculture.*

The beginner in diagnosis rarely appreciates the difficulties in recognizing and differentiating disease, consequently many mistakes are made and there results a lack of confidence in his own ability. Certainly this is deplorable. In this paper it is aimed to point out certain difficulties in the gross diagnosis of the infectious brood diseases of bees in such manner that the inexperienced inspector may profit thereby and it is hoped that those of greater experience may find something of value in the recital of some of the difficulties which have been encountered in the examination of over 4,500 different specimens of bee comb and brood representing every section of the United States.

Dead, Not Living, Larvæ Must Be Studied

The few published characteristics of living diseased larvæ are not readily applicable to gross diagnosis, especially in the field, consequently attention must be directed for the present almost exclusively to dead larvæ.

Variations in the Same Disease

The various factors entering into a description of the dead brood in any one of the three known infectious brood diseases of bees are not constant, thus resulting in different appearances in different cases of the same disease. It is this variation that makes a differential gross diagnosis at times difficult or even impossible so that laboratory aid must be sought.

Consideration of the Variations at Length

It will be well to consider some of the more striking variations at greater length. Many lay great stress upon the value of odor in American foulbrood and European foulbrood. There is no doubt that most of the cases of American foulbrood, probably all, have at some time in the course of the disease a characteristic odor. The same cannot be said of European foulbrood for the odor here seems accidental and is not always present, more-

over, a very similar odor may be present in other conditions, probably in brood which has died from almost any cause, barring American foulbrood and sacbrood. The odor in American foulbrood may be very feeble, or absent altogether, and probably sometimes disappears on exposure to the air outside of the hive. Infected brood in the comb will undoubtedly absorb other odors if given the opportunity, thus the original characteristic odor of American foulbrood may be masked. This has been observed where specimens of comb and diseased brood from various sources have been thrown together in the waste basket and carted to the basement and allowed to lie there for some time preparatory to being destroyed. No odor has been detected in sacbrood. Odor is of value, therefore, only in American foulbrood. Color is usually regarded as of considerable value in differentiating between American foulbrood and European foulbrood. This is true in many cases but coloration is not by any means constant for either disease. Thus the coloration in some cases of American foulbrood, where young larvæ are affected, may closely resemble the usual coloration of most cases of European foulbrood. This usually leads to the mistake of diagnosing American foulbrood as European foulbrood or to that of diagnosing the presence of both diseases in the same comb. The consistency of the broken down larval mass is one of the most constant factors, yet this may not be sufficiently pronounced, as for instance the ropiness in American foulbrood, to differentiate as between it and European foulbrood. Especially confusing are those cases where in addition to the lack of ropiness there is present, as just mentioned in some cases of American foulbrood, coloration closely resembling European foulbrood. The age of the infected larvæ is usually an important aid in diagnosing between American foulbrood and European foulbrood. Every beekeeper, who knows anything about disease at all, has learned that in American foulbrood it is the older larvæ as a rule, or even pupæ, that present the manifestations of disease, while in European foulbrood diseased larvæ, much younger than in most cases of American foulbrood, are found. It not infrequently happens that the germs of American foulbrood give evidence of their presence in the larvæ at about the age at which European foulbrood usually manifests itself and, to increase the difficulties of differentiating, again the coloration of the larvæ and the general appearance may very closely simulate European foulbrood. To illustrate some of the variations just enumerated, I wish to describe for you the following specimen of diseased brood: Specimen No. 4725 from the apiary of John Kessler, Watertown, Jefferson County, Wisconsin, sent by Mr. L. V. France and examined by the writer July 1, 1915. The sample, it was stated, was obtained June 29, 1915, hence was examined pre-

sumably within 48 hours after removal from the hive. Mr. France wrote: "I have diagnosed the condition as American and European foulbrood both in the same comb." There were two pieces of comb each from a different colony. On opening these specimens of brood and before a miscroscopic or bacteriological examination, a tentative gross diagnosis of European foulbrood was made. On examining microscopically no evidence of either *Bacillus pluton* or *Bacillus alvei* could be found but spores of apparently *Bacillus larvæ* were present in abundance. On making bacteriological cultures the diagnosis of American foulbrood was confirmed instead of the tentative gross diagnosis of European foulbrood. No one could be blamed for making the mistake of diagnosing in the gross these two samples as European foulbrood. The affected larvæ in great number were young—about the age at which European foulbrood is seen in most of the samples received for diagnosis. Moreover, the larvæ presented the same yellow, grey and brown shades usually seen in European foulbrood and exhibited furthermore that peculiar appearance which the writer has described as melted, the larvæ presenting a moist collapsed mass as though gradually melting away under the influence of heat. In fact, there was practically nothing in the specimen to indicate by sight any other condition than the familiar appearance of many of the cases of European foulbrood. However, on thrusting the forceps, used in examining suspected brood, into the dead larvæ, it was noted that the consistency of the larvæ was more like American foulbrood than European foulbrood. These larvæ, as small as they were, showed an inclination to rope out more than would be expected from larvæ affected with European foulbrood and the larval mass was viscid in contradistinction to the more friable condition of European foulbrood larvæ. On continuing the examination, older larvæ, still more distinctly viscid, were found. Moreover, the cappings of most of the affected larvæ in both pieces of comb were sunken and only a few perforated cappings were found. However, neither sunken nor perforated cappings can be considered of any great value, both apparently being accidental features. Perforated cappings, especially, are liable to be found wherever pupæ die in sealed cells from any cause. Thus it will be seen that this specimen of diseased bee brood does not fit in well with the described condition applicable to either American foulbrood or European foulbrood for most cases. It is likely that, if this specimen could have been seen after the larvæ had formed the scale, differentiation would have been easy. Unfortunately, the comb was destroyed and later observations could not be made.

Consideration of Scales

This brings us to a consideration of the scales of the infectious brood diseases, especially those of American foulbrood and European foul-

brood. The scales of these diseases, as you all know, are formed by the drying of the affected larvæ. The character of these scales is usually so different that there is little danger of confusing one with the other. The scales of American foulbrood are so characteristic that a positive diagnosis of the disease in this stage can almost invariably be made. Let it be distinctly understood that a number of scales, not a single scale, is sufficient to make such positive diagnosis. It is not uncommon to receive for diagnosis, specimens of comb with a single affected larva, often in the form of a scale. Certainly no one should presume to make a gross diagnosis from such meagre material. Yet the same has been done and if the diagnosis was later confirmed by finding other infected larvæ in the colony, the original diagnosis should be considered good luck rather than skill. A laboratory diagnosis even, from a single larva, is frequently considered unsatisfactory by the examiner. Specimens are often received for diagnosis containing less than half a dozen scattered scales, or even a single scale of rubber-like consistency, which in coloration, position of being stretched out from base to top along the lower cell wall, and even difficulty with which it separates, all indicate scales of American foulbrood and no doubt such scales have been diagnosed as belonging to this disease. Closer examination, however, will usually reveal such scales to be of a lighter shade of brown than the scales of American foulbrood and they are not found in such great number in a given area of comb as American foulbrood scales. The decided rubber-like quality exhibited on attempting to break or draw out these scales, should put one on guard.

Besides these large rubber-like scales of European foulbrood there is the much more common form described as being smaller than American foulbrood scales, greyish-brownish or yellowish in color and lying usually against the base of the cell. These small scales are not nearly so characteristic of European foulbrood as are the scales described for American foulbrood. Larvæ dying from other causes may bear quite a close resemblance to the small greyish, brownish or yellowish scales of European foulbrood. The rubber-like scales of European foulbrood occur infrequently and in small numbers, hence in a small piece of comb might be mistaken for scales of American foulbrood. European foulbrood cannot be diagnosed in the scale stage with the certainty that American foulbrood can. In fact, it is practically impossible to diagnose European foulbrood after it has passed to the scale stage.

Scales are sometimes found in specimens of sacbrood. These are often quite dark, even black in coloration, sometimes with tint of grey, especially the under surface in contact with the cell wall from which they separate quite readily. The peculiar distended condition and granular watery content of larvæ affected with sacbrood should make

this condition in this stage easily diagnosed. The scale stage offers greater difficulties in gross diagnosis.

Consequences of Mistakes in Diagnosis

While the difficulties of diagnosis are such that errors must be made, yet these should be reduced to a minimum. The undesirable consequences following the application of improper treatment, based on a mistake in diagnosis, are obvious. Almost all of the mistakes possible have been made: thus, sacbrood has been mistaken both for American foulbrood and European foulbrood, likewise European foulbrood for American foulbrood and vice versa and treatment ordered accordingly, including unnecessary destruction of the frames and the rendering of the combs into wax with the consequent additional labor. Such mistakes as the above have been reported and unnecessary losses to the beekeeper could have been avoided by exercising proper discretion. It is better in doubtful cases to send a specimen for laboratory diagnosis. Mistakes are not so dangerous if made in a badly diseased territory since the chances of error in such cases are greatly reduced. But it is certainly desirable to have the diagnosis of suspected brood in a new territory confirmed unless there is so much suspected brood as to leave little doubt of infection.

OUTLINE OF APIARY INSPECTION IN ONTARIO

By Morley Pettit, *Provincial Apiarist, Guelph, Ontario*

It might be well to mention by way of introduction that the province of Ontario has a total area of four hundred thousand square miles, being much larger than any state of the Union. Only about 10 per cent of this area is as yet occupied, although every part has good agricultural districts as well as great mineral resources. The agricultural output of 1914 is valued at seven hundred and fifty million dollars.

Bees have been successfully kept in almost all parts of the province, and there are at present upwards of ten thousand persons keeping about three hundred thousand colonies and producing average crops of from 30 to 50 pounds per colony. The Ontario Beekeepers' Association has been in operation for 35 years and now has twenty-six affiliated county associations and a total membership of about twelve hundred. The annual government grants to beekeeping total about $10,000.00, only a part of which can be used for apiary inspection.

On the first enactment of foulbrood legislation in Ontario in 1890, one inspector was appointed by the Ontario Beekeepers' Association to spend part of his time inspecting bees under the direction of the president. In 1906 the act was revised and the province divided into

districts with a local inspector in each under the direction of the Minister of Agriculture. The present provincial apiarist was appointed in 1909 and given charge of the inspection system.

The present organization consists of the following divisions:

1. Bee disease legislation; 2. Conference and training of inspectors; 3. Educational correspondence with beekeepers to sustain interest and coöperation; 4. The bulletin on "Bee Diseases"; 5. Apiary demonstrations; 6. Field work of inspectors; 7. The system of reporting and centralization of control; 8. Organization of the central office.

Under the legislation, the number of inspectors is not restricted. They are appointed on the recommendation of the Minister of Agriculture, who usually consults the Provincial Apiarist. They work under his direction and are required to destroy the worst cases of disease, only leaving instructions for the cure of milder cases. They are authorized to order the transferring of colonies out of box hives. A heavy penalty is placed on the beekeeper for disposing of diseased bees or appliances in any way, and persons whose bees have been treated or destroyed for disease are forbidden to dispose of any bees or appliances whatever without permission from the inspector, on penalty of fine or imprisonment. Every person who is aware of the existence of foulbrood is required to report the same to the Minister of Agriculture on penalty of a fine.

The Inspectors' Conference is held at the Ontario Agricultural College at the time of the Beekeeping Short Course in January. Methods of inspection are fully discussed by the inspectors and resolutions passed by them which commit them to a uniform policy of inspection work for the ensuing season.

During the early part of May some undergraduate specialists in beekeeping are given a course of training as inspectors and demonstrators. Most of these men have made good despite the opposition of some older beekeepers. Incidentally it is a part of their training as graduate specialists. Several have returned home to keep bees and are now making the best of local inspectors.

Under the slogan "Every beekeeper his own inspector," the coöperation of beekeepers themselves is sought by correspondence. First a letter is sent to the complete list early in spring warning against the danger of spreading disease by allowing robbing, and advising all owners of bees in box hives to prepare for transferring them during the swarming season.

Early in May, a letter goes to the disease list asking the beekeeper to be his own inspector and enclosing a report form with agreement to treat by a stated time, and a report of treatment to be signed and returned later. Returns from this are filed with the disease list. The

Ontario Department of Agriculture Bulletin 213, "Bee Diseases in Ontario," is also sent to those who have not previously received it.

Apiary demonstrations are arranged and advertised by form letters and cards sent out from the central office. Thanks are due the secretaries of county beekeepers' associations and the district representatives of the Department of Agriculture for much assistance in these arrangements. As far as possible each inspector conducts demonstrations in his own district.

When the weather is fairly well settled about May 24, inspectors are instructed to start work and cover as much territory as possible before the grant is exhausted. Reports are sent in daily and accounts weekly. The bookeeper gives notice when the money is nearly all used, and all are ordered to cease operations, except in very special cases. The objection to a geographical division of the grant is two-fold: viz., the importance of an early discovery of cases of disease and the inclination of local inspectors to postpone work until everything is well looked after at home. Neglected districts very soon complain and the responsibility is then placed where it belongs.

As the grant has never been sufficient to inspect all known cases of disease, work is done in districts where the interest is best and the disease worst. With American foulbrood, the district is worked over thoroughly, but with European foulbrood, the ground is seldom covered the second time as this disease soon eliminates careless beekeepers.

Treatment is based on a diagnosis of symptoms of the beekeeper quite as much as of his bees. To this end the inspector is given forms which combine the record of past inspection with the current year's report. The form is a 5″ x 8″ card with heading showing the beekeepers' name and address, and exact location of apiary; also his rating as a "good," "average" or "poor" beekeeper and other items as to style of hive, etc. The results of inspection are reported in vertical columns with appropriate headings, one horizontal line being used each year.

The complete list of beekeepers for the district is sent to the inspector in these forms, also some blanks for new names. He is not expected to visit apiaries where disease is not suspected; but without going to extra expense is requested to revise all forms as far as possible, returning them from day to day with reports of inspection. Thus the disease inspector is also taking a bee survey of his district.

When disease is found and not destroyed, a small white label is pasted on the hive, showing the date and nature of disease. A red label covers this at the time of treatment. The beekeeper is required to sign an agreement to treat before a specified date. This is forwarded with the report of inspection and requires the beekeeper's signed statement of treatment at the proper time. If the report of treatment

is delayed, a letter goes to the beekeeper which usually gets a response. As far as possible the inspector looks after these cases next season and burns diseased material in cases of neglect.

In the central office the vertical system of cards and folders is used exclusively for keeping records. These are filed by a geographical numbering system which is easily explained. Each Ontario beekeeper is assigned a number of seven figures—the first two for his county, the second two for his township and the last three for his place among the beekeepers of his township. His 5″ x 8″ record card gives in condensed form most of the information we have of him as a beekeeper. There is also a 3″ x 5″ card index of the card record, arranged alphabetically by a numbering system, technically called the "L.B. Automatic Index." The list of beekeepers is on stencils for an addressing machine arranged geographically by numbers. This makes it easy to advertise local meetings in any part of the province. It is also useful for supplying lists of beekeepers to county secretaries, district representatives and others.

Practically every labor-saving device that it would be profitable to use in an office of this kind has been secured. These include in addition to the addressing machine, a stamp affixer, envelope sealer, duplicating machine and dictating machine.

Without the means to inspect all apiaries in a few years, a definite statement of the disease situation cannot be given. There is no hope of eradicating disease for some time at least; but by education the morale of the beekeeper is much improved, and with the passing of the neglected farm apiary, the chief disease menace to amateur and commercial beekeeping is removed.

The following items, from the 1915 Annual Report on "Apiary Inspection in Ontario," may be of interest. Twenty-one inspectors were employed for what time they could spare from home during the month of June. In the European foulbrood districts visits were made to 391 apiaries, containing 5,367 colonies. One hundred and ninety-four of these apiaries were diseased, the number of diseased colonies being 1,387. In the American foulbrood districts, 611 apiaries were visited, consisting of 10,825 colonies. One hundred and seventy-nine apiaries were found diseased, the number of diseased colonies being 921. As previously stated, inspection in European foulbrood districts was only on the outskirts. In many cases the infection was slight and was under control. The inspector's work consists mainly in warning against the danger of black bees and weak colonies.

The inspectors of American foulbrood report about the same percentage of disease as last year. This is encouraging as the failure of the honey crop in 1914 and resultant robbing was expected to spread disease.

Proceedings of the Fourteenth Annual Meeting of the American Association of Official Horticultural Inspectors

The fourteenth annual meeting of the American Association of Official Horticultural Inspectors was held in Columbus, Ohio, December 28 and 29, 1915. On the evening of December 28 the first session was called to order in the House of Representatives, State Capitol, by the Chairman, W. E. Rumsey, with J. G. Sanders, Secretary.

The second session was held in the Botany and Zoölogy Building of the Ohio State University at 10.00 a. m. Wednesday, December 29.

The Legislative Committee of the National Nurserymen's Association was represented on invitation by Mr. J. H. Dayton of the Storrs & Harrison Co., Painesville, Ohio, who reported on the acceptance of the Uniform Inspection Bill by the nurserymen at their national convention in Detroit, Michigan, in June, 1915. Mr. Dayton reported that it was a gratifying advance in horticultural legislation to note the closer feeling of coöperation among the nurserymen and the entomologists. He conveyed the sentiments of the nurserymen to our Association and expressed a wish for the continued good feeling and coöperation existing at present.

The program as presented at the two sessions of the meetings was as follows:

Program

Tuesday, December 28, 1915, 8.00 p. m.

1. Address of the Chairman: "Control of the Cedar Rust in West Virginia," by Professor W. E. Rumsey, Morgantown, W. Va.
2. "Foreign Pests Recently Established in New Jersey," by Harry B. Weiss, New Brunswick, N. J. (10 minutes.)
3. "Imported Insect Pests Collected on Imported Nursery Stock in 1915," by E. R. Sasscer, Washington, D. C. (10 minutes.)
4. "The Uniform Horticultural Inspection Law," by J. G. Sanders, Madison, Wis. (10 minutes.)
5. "Report of the Legislative Committee of the National Nurserymen's Association," by J. H. Dayton, Painesville, Ohio.

Wednesday, December 29, 1915, 10.00 a. m.

6. "Remarks on Inspection Facilities in the District of Columbia," by E. R. Sasscer, Washington, D. C. Illustrated. (10 minutes.)
7. "Vacuum Fumigation and Its Application to the Control of Insects Affecting Plants and Plant Products," by E. R. Sasscer, Washington, D. C. Illustrated. (15 minutes.)
8. "The Betterment of Pathological Inspection," by R. Kent Beattie, Washington, D. C.
9. "Nursery Inspection in Florida," by F. M. O'Byrne, Gainesville, Fla.

10. "Coöperation in the Establishment of State Quarantines," by J. Edward Taylor, Salt Lake City, Utah.

11. "The Ohio Inspection System," by N. E. Shaw, Columbus, Ohio. Illustrated. (15 minutes.)

Business

Professor W. J. Schoene, Blacksburg, Virginia, was nominated as Chairman of this section for 1916, and J. G. Sanders, Madison, Wisconsin, was reëlected Secretary.

The following persons were in attendance at the sessions of the meetings:

Ed. L. Ayers, Austin, Tex.
R. Kent Beattie, Washington, D. C.
Geo. G. Becker, Fayetteville, Ark.
G. M. Bentley, Knoxville, Tenn.
E. C. Cotton, Elyria, O.
J. H. Dayton, Painesville, O.
Geo. A. Dean, Manhattan, Kan.
D. M. DeLong, Columbus, O.
Harry F. Dietz, Indianapolis, Ind.
H. E. Evans, Columbus, O.
W. E. Evans, Jr., Painesville, O.
Richard Faxon, Elyria, O.
E. P. Felt, Albany, N. Y.
F. A. Fenton, W. Lafayette, Ind.
S. B. Fracker, Madison, Wis.
F. D. Heckathorn, Painesville, O.
E. J. Hoddy, Columbus, O.
Neale F. Howard, Columbus, O.
S. J. Hunter, Lawrence, Kan.
B. F. Kindig, Elkhart, Ind.
Max. Kislink, Jr., Washington, D. C.
R. W. Leiby, Raleigh, N. C.
P. W. Mason, LaFayette, Ind.
R. S. McKay, Owensville, O.
E. M. Mendenhall, Columbus, O.
G. B. Merrill, N. Abington, Mass.
Joseph H. Merrill, Manhattan, Kan.
Harold Morrison, Indianapolis, Ind.
H. Ness, Ames, Iowa.
Owen Nelson, Laramie, Wyo.
F. M. O'Byrne, Gainesville, Fla.
L. M. Peairs, Morgantown, W. Va.
Morley Pettit, Guelph, Ont.
W. A. Price, LaFayette, Ind.
Jesse M. Robinson, Columbus, O.
Lowell Roudebush, New Richmond, O.
W. E. Rumsey, Morgantown, W. Va.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, W. LaFayette, Ind.
W. J. Schoene, Blacksburg, Va.
Geo. D. Shafer, East Lansing, Mich.
N. E. Shaw, Columbus, O.
Mrs. L. C. R. Smythe, Topeka, Kan.
Perley Spaulding, Washington, D. C.
H. J. Speaker, Sandusky, O.
J. Edward Taylor, Salt Lake City, Utah.
F. L. Thomas, Auburn, Ala.
J. Troop, LaFayette, Ind.
Geo. H. Vansell, Lexington, Ky.
C. H. Waid, Wauseon, O.
Frank N. Wallace, Indianapolis, Ind.
R. L. Webster, Ames, Iowa.
Don B. Whelan, East Lansing, Mich.
P. B. Wiltberger, Columbus, O.
L. H. Worthley, Boston, Mass.

Summary of Papers and Discussions

1. Address of the Chairman. Professor Rumsey described the losses occasioned by the "cedar rust" on the apple crop in West Virginia and outlined the steps taken for controlling the situation, which included the destruction of cedars over a large area. Some conflict with property owners was encountered but after tactful maneuvering the situation was cared for and the difficulties overcome. The situation is gratifying at the present time. Dr. Headlee asked what diameter

of zone was considered necessary for immunity from the "cedar rust" disease. Mr. Rumsey replied that one mile from commercial orchards was decided as necessary distance and this plan was carried out wherever possible. Remarks were made by several relative to the compensation for destruction of property in cleanup work for diseases and pests.

2. Mr. Weiss' paper, which listed the many species of insects which have been recently introduced and have become established in New Jersey, was presented by Dr. Headlee who supplemented the paper with remarks in which he recommended rather drastic action to prevent repetition of these alarming conditions. During the discussion it was moved by Dr. Headlee "that it be the sense of this body that the federal quarantine be strengthened, and that an absolute quarantine be placed on all plants imported with soil about the roots, except such as are introduced by the U. S. Department of Agriculture for experiment and those to be held in quarantine for a reasonable period." This motion was passed unanimously and the Secretary instructed to notify the Federal Board of this action.

It was further suggested by one of the members, that state inspectors should convey their suggestions and judgment on inspection matters to the Federal Horticultural Board; and further, that state inspectors and officials take notice of hearings before this Board (which are usually advertised), and that whenever possible should be present at these meetings.

Mr. Burgess reported that Christmas trees and greens to the extent of over forty-one carloads, containing 1,200 to 1,800 trees each, had been shipped from the quarantine area in New England, all of which had been inspected previous to shipment and a considerable number of egg clusters of the gipsy moth had been found on these trees. All carload lots went from New Hampshire and Maine and had been shipped to many of the states of the Union, including such states as Michigan, Wisconsin, Minnesota, Washington and Oregon, where already grows a plentiful supply of Christmas trees and greens.

It was the sense of the inspectors present that the Federal Quarantine should be replaced on Christmas greens, otherwise several of the states would absolutely quarantine the shipments of Christmas trees originating in the moth quarantine area.

3. "Imported Insect Pests Collected on Imported Nursery Stock in 1915," by E. R. Sasscer, Washington, D. C.

In this paper, which will appear later in the Journal, Mr. Sasscer reports special features of the inspection of imported nursery stock under the Federal Plant Quarantine Act. He called attention to the annually increasing amount of imported nursery stock, and reported

the detection of a number of dangerous insects. Special attention was called to the fact that recently two troublesome insects, namely, the European ear-wig and the European mole cricket, had become established in certain eastern states. It is the belief of the writer that these insects had been introduced in soil about the roots of imported plants.

4. The Secretary reported that the Uniform Horticultural Inspection law, which had been under consideration for three years, had been considered by a committee appointed at the last annual meeting and alterations and improvements were made in the bill.

This bill was finally adopted by the National Nurserymen's Association in their annual meeting in Detroit in June, 1915, and Mr. Curtiss Nye Smith of Boston had been retained as their attorney to aid in the adoption of this bill, wholly or in part, wherever changes in state horticultural inspection laws were contemplated.

5. The substance of Mr. Dayton's remarks appears on a previous page.

6. Mr. Sasscer explained the convenient arrangement of buildings and apparatus for inspection of material introduced into the District of Columbia, and described the extreme precautions for sanitation where suspected plant material was being examined and quarantined.

7. Mr. Sasscer's paper on vacuum fumigation is withheld for publication elsewhere, but the importance of the results which he has secured in fumigating tightly packed bales of cotton by the vacuum processes, using cyanide gas, marks a greatly advanced step in fumigation methods. We can scarcely realize what may be the ultimate outcome of this method of successful fumigation.

8. Mr. Beattie's plea for more carefully trained inspectors was gratifying. He illustrated by several examples what diseases have become established through inefficient and poorly trained inspectors where recognition of dangerous plant diseases was not possible until too late.

9. Nursery inspection conditions in Florida were outlined by Mr. O'Byrne, whose paper will be published later.

10. Mr. J. Edward Taylor described the conditions regarding state quarantines in the West, which were not desirable, and pleaded for greater coöperation among the states. He spoke particularly regarding the effect of unfortunate state quarantines on the shipment of alfalfa seed with regard to possible alfalfa weevil infestation.

11. Illustrated with a series of fine slides, Mr. Shaw described the Ohio system of nursery inspection and the methods used in inspection and fumigation of infested stock. A number of fumigation houses of different types were illustrated and valuable pointers in fumigation house construction were offered.

CONTROL OF THE CEDAR RUST IN WEST VIRGINIA

ADDRESS OF THE CHAIRMAN

By W. E. Rumsey, *Morgantown, W. Va.*

Gentlemen: To have the honor of presiding at a session of our Association is certainly appreciated by your present chairman. An elaborate address will not be attempted but some remarks may be appropriate at this time concerning the "snags" encountered by West Virginia in attempting to enforce certain features of her nursery and orchard inspection laws. Therefore, with your indulgence, the eradication of red cedars in the vicinity of apple orchards will be considered.

The damage by apple rust or so-called "cedar rust" to orchards in the eastern panhandle of our state has been enormous, amounting to $75,000.00 in 1912 in Berkeley county alone. This is a conservative estimate and includes merely the loss to the crop for that year, not taking into consideration the devitalization of the trees which prevented them from developing fruit-buds for a succeeding crop.

Since the scope of our crop pest law includes any dangerously injurious insects or plant diseases that are liable to spread and cause damage, the commission decided to make an effort to check apple rust by the removal of red cedars in sections where the apple industry had developed sufficiently to make the cedar trees a nuisance. Spraying for this disease is not practical commercially as has been determined by investigations of our plant pathologist, N. J. Giddings, and others, hence the only recourse is the removal of cedars.

The cedar tree proposition is rather unique. These trees have been growing in certain portions of our state since time immemorial, and it has been only within the last few years that the disease, which cedars harbor, has caused any serious loss to apple crops. At the present time these trees do the general farmer no particular harm except to take his pasture fields, for the cedars come up from seeds like weeds and it is said that no kind of stock will eat even the young plants. Besides this there is an æsthetic side that must not be ignored. Long stretches of cedars on both sides of country roads and clumps of them, clothed in perpetual green, covering many rocky knolls and ledges of the limestone outcrop, add much to the scenic beauty of the Shenandoah Valley.

Owing to the prevalence and destructiveness of apple rust in Berkeley county, one of the foremost apple sections of our state, the commission began its activities in this territory. On account of the unique-

ness of this work, as already pointed out, it was deemed advisable to start off with a campaign of education. Therefore, the state entomologist was sent into the territory to visit the general farmers and convince them, first: that cedar trees were responsible for the great loss from apple rust to the orchard industry of their community, and, second: that for the benefit of their county they should coöperate with the orchardists in the fight against this disease. Other duties of the entomologist compelled him to leave the field and a local inspector was appointed to continue the work. It soon became evident that the fruit-growers did not like the policy adopted by the commission for they began "nagging" at our inspector to resort to the law and cut the cedars under its provision. This attitude of the orchardists at once counteracted any impression we may have made toward obtaining coöperation and there arose two fighting factions: the general farmers uniting to prevent the work of the state, declaring the law to be unconstitutional, and the orchardists clamoring for a test case to be brought before the court. Under these circumstances the commission could not back down, so in February, 1914, cedar cutting began on the property of an extensive land owner who immediately had the inspector and his helpers arrested and got out an injunction to restrain the commission and any of its employees from entering upon his premises. It was now evident that to get the cedars removed other tactics must be used. Therefore the entomologist returned to the front and visited the trenches of the opposing forces as a sort of peacemaker. He obtained permission from the general farmers to allow the removal of their cedars provided the work would be done strictly in accordance with their wishes under the supervision of a state man and without cost, the orchardist furnishing the labor. The fact was pointed out to the fruit-growers that if the commission persisted in its efforts to enforce the law many other farmers would undoubtedly get out injunctions which would prevent cedars being cut on such premises until after the litigations were adjusted. However, it was stated that permission had been obtained from the general farmers to cut their cedars provided it was of no expense to them. Therefore, labor must be furnished by the orchardists to remove these trees if they wished to save the apple crop. The fruit-growers readily fell into line and thus the tactics adopted proved successful. Immediately a different atmosphere seemed to pervade the community and cedar trees fell by the tens of thousands with a result that apple rust was checked to a marked degree.

Although the court has decided that our inspection law is constitutional we are still removing cedars under the plan just described, for by so doing, not only peace and good will prevail between the general

farmers and fruit-growers, but all the cedar trees on a tract are cut at once. If we were removing the cedars in strict accordance with the law, only those harboring cedar apples or balls could be cut, hence making it necessary to go over the ground year after year to destroy other cedars that have become infected since the previous inspection.

A MODEL STATE HORTICULTURAL INSPECTION LAW[1]

By J. G. Sanders, *Madison, Wis.*

Greater uniformity in legislation of the various states regulating the inspection and transportation of nursery stock and horticultural inspection generally, was discussed in this Journal[2] in 1914.

At the Atlanta meeting of our Association the writer offered for consideration a preliminary draft of a horticultural inspection bill, which would, through its text or by the promulgation of rules and regulations, cover practically all phases of inspection and emergencies which would arise under the inspection work.

The bill was discussed by the inspectors present and also by members of the Legislative Committee of the National Nurserymen's Association, who were invited to attend our meeting. The writer, working in coöperation with members of the Inspectors' Association and the Legislative Committee of Nurserymen, revised and redrafted a bill which was again presented at the Philadelphia meeting. Here various suggestions for improvement were offered and a committee of five was appointed to confer as to the final wording of the bill and having power to act. Various conferences were held with Mr. William Pitkin, Chairman of the Nurserymen's Legislative Committee, and suggested changes for improvement were made in the bill.

In June, 1915, at the Detroit meeting of the National Nurserymen's Association, the bill, as drafted and as is published herewith, was finally adopted.

The great interest manifested in uniform legislation by the nurserymen, and particularly their willingness to adopt a bill so drastic in its power as the present one, is most praiseworthy. A marked change in feeling between the nurserymen and the entomologists and inspectors has taken place, each of the contending parties realizing more keenly the problems of the other. The nurserymen, we feel sure, are coming to realize the importance of more careful and thorough inspection, and to realize the necessity for coöperation and assistance in this work.

[1] Prepared and adopted by the American Association of Official Horticultural Inspectors and the American Association of Nurserymen.

[2] Jour. Econ. Ent., vii, p. 102, 1914.

The nurserymen have expressed themselves strongly in favor of more thorough training of inspectors and more careful work to insure clean stock and fewer mistakes in the condemnation of stock without warrant.

The entomologists and inspectors fully appreciate the present situation which is handicapped to a greater or less degree in some states by lack of funds for the employment of better trained and more experienced men.

State laws, which are as nearly uniform as local conditions will permit, will aid wonderfully in the inspection, fumigation, packing and transportation of nursery stock. Hence, we believe that the adoption of this bill, which has been worked over with great care by entomologists and nurserymen with the aid of legal advice, will materially assist in undesirable conditions which now exist where each state has its own provisions differing widely from those of its neighbor. The Uniform Bill as offered should be adopted as nearly as possible in its presented form, when changes are contemplated in state laws. The Nurserymen's Association has offered their assistance through their national body, as well as their state organizations, to further this project, and those interested should feel free to call on them for help.

The bill as offered is not presumed to be perfect, but is thought to cover all possible exigencies which may arise either through the text offered or by the power for promulgation of rules and regulations as provided in section 6.

The writer, as Secretary of the Inspectors' Association, will be glad to aid in the adoption of horticultural laws whenever his assistance is desired.

A MODEL STATE HORTICULTURAL INSPECTION LAW

NOTE—The parenthetical words and phrases are to be understood as options suitable to local state conditions and usage.

[Bill No.——, Approved —— 19——. Chap. or Sec.——, Laws of———]. Be it enacted by the (Legislature) (people) of the state of —— (represented in) (General Assembly) (Senate and Assembly) that,—

Section 1.—The following terms as used in (this act) (sections —— to ——, inclusive) shall be construed as follows:—

1.—The singular and plural forms of any word or term in (this act) (section —— to ——, inclusive) shall be construed as interchangeable and equivalent within the meaning of the act.

2.—The term "person" shall include corporations, companies, societies, associations, partnerships or any individual or combination of individuals. When construing and enforcing the provisions of (this act) (sections —— to ——, inclusive) the act, omission, or failure of any officer, agent, servant or other individual acting

for or employed by any person as above defined within the scope of his employment or office, shall in every case be also deemed to be the act, omission or failure of such person as well as that of the individual himself.

3.—The terms "insects" and "plant diseases" appearing in (this act) (sections —— to ——, inclusive) shall be construed to include any stage or stages of development of the aforesaid insects or plant diseases.

4.—The term "nursery stock" shall include all field-grown florist stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit-pits and other seeds of fruit and ornamental trees and shrubs, and other plants and plant products for propagation, except field, vegetable, and flower seeds, bedding plants, and other herbaceous plants, bulbs and roots.

5.—The term "nursery" shall be construed to mean any grounds or premises on or in which nursery stock is propagated and grown for sale, or any grounds or premises on or in which nursery stock is being fumigated, treated, packed or stored.

6.—The term "nurseryman" shall mean the person who owns, leases, manages or is in charge of a nursery.

7.—The term "dealer" shall be construed to apply to any person not a grower of nursery stock who buys nursery stock for the purpose of reselling and reshipping, independently of any control of a nursery.

8.—The term "agent" shall be construed as applying to any person selling nursery stock under the partial or full control of a nurseryman, or of a dealer or other agent. This term shall also apply to any person engaged with a nurseryman, dealer or agent in handling nursery stock on a coöperative basis.

Section 2.—There is hereby created a board which shall be known as the "Horticultural Inspection Board" of (State), hereinafter called the Board, consisting of three (five) members, two (four) members of which shall be ex-officio members. The third (fifth) member shall be appointed by the Governor for a term of four years. Such third (fifth) member shall be a nurseryman actively engaged in the growing of nursery stock. A majority of the members of the Board shall constitute a quorum. Vacancies occurring from death, resignation, removal or inability to act shall be filled in like manner for the unexpired term. The members of said board shall elect a chairman and shall serve without compensation, but shall receive their actual and necessary traveling expenses incurred in the discharge of their official duties within the provisions of (this act) (sections —— to ——, inclusive). This board is hereby vested with all powers necessary to carry out the provisions of (this act) (sections —— to ——, inclusive).

Appointment

Section 3.—The Board shall appoint some person qualified by scientific training and practical experience to be state nursery inspector, hereinafter called the inspector who shall hold his office during the pleasure of the Board, and shall strictly enforce the provisions of (this act) (sections —— to ——, inclusive) as a police regulation of the (state) (commonwealth) under the direction and control of the Board.

Bond

Section 4.—The inspector shall file with the Board a bond with security to be approved by the Board in the sum of one thousand dollars, conditioned on faithful performance of his duty. Any person suffering loss occasioned by reason of an act or omission of the inspector and deputies which is deemed to be unjustifiable, may maintain an action upon said bond against the inspector and sureties thereon

for such loss not to exceed the amount of said bond. Indemnity bonds with sufficient sureties running to the inspector and the sureties upon his bond may be required of deputy inspectors.

Appointment of Deputies

Section 5.—The Board is hereby authorized to appoint or dismiss on the recommendation of the inspector (deputies) (county horticultural inspectors) (district horticultural inspectors) who shall strictly enforce the provisions of (this act) (sections —— to ——, inclusive) under the direction of the Board, and they are hereby endowed with the same police power as the inspector, and shall be furnished with official badges or other insignia of authority, which shall be carried while on duty.

Section 6.—The Board shall have the power to prescribe, modify and enforce such reasonable rules, regulations and orders as may be needed to carry out the provisions of this act, and may publish an annual report describing the various phases of the inspection work, or may publish such other information as may seem desirable concerning the inspection and such insects and diseases as are covered by (this act) (sections —— to ——, inclusive). Such rules and regulations shall be printed from time to time and furnished free to interested parties.

Inspector's Duties and Powers

Section 7.—The Board through the inspector or deputies shall at least once each year inspect all nurseries and other places in which nursery stock is kept for sale. For this purpose such inspector or deputies shall have free access, within reasonable hours, to any field, orchard, garden, packing ground, building, cellar, freight or express office, warehouse, car, vessel, or other place, which it may be necessary or desirable for him to enter in carrying out the provisions of this act. It shall be unlawful to deny such access to the inspector or deputies or to hinder, thwart or defeat such inspection by misrepresentation or concealment of facts or conditions or otherwise.

Section 8.—The Board through the inspector or deputies shall have the authority to inspect any orchard, fruit or garden plantation, park, cemetery, private premises, public place, and any place which might become infested or infected with dangerous or harmful insects or plant diseases. It shall also have the authority to inspect or reinspect at any time or place any nursery stock shipped in or into the state and to treat it as hereinafter provided.

Diseased Plant Material on Premises

Section 9.—The Board is hereby empowered to prohibit and prevent the removal or shipment or transportation of plant material and any other material from any private or public property, or property owned or controlled by the state, or any area of the state (commonwealth) which in its judgment contains dangerously infested or infected nursery stock or plant or other material of any kind for such periods and under such conditions as in its judgment seems necessary in order to prevent the further spread of the infestation or infection, giving such notice thereof as may be prescribed by the Board; and during the existence of such order no person shall remove or ship from such area any such material whatsoever, except by special permission or direction of the Board.

Section 10.—It shall be unlawful for any person in this state knowingly to permit any dangerous insect or plant disease to exist in or on his premises. It shall also

be unlawful to sell or to offer for sale any stock infested or infected with such insect or disease.

Section 11.—In case the inspector or deputy shall find present on any nursery or dealer's premises or any packing ground or in any cellar or building used for storage or sale of nursery stock, any injurious insect or plant disease, he shall notify the owner or person having charge of the premises, in writing, to that effect, and the Board shall withhold his certificate hereinafter provided for, until the premises are freed from such injurious insect or plant disease, as hereinafter provided. It shall be unlawful for any person after receiving such notice to ship or deliver or cause to be shipped or delivered any nursery stock from such aforesaid premises.

Section 12.—(1) If the inspector or deputy shall find on examination any nursery, orchard, small fruit plantation, park, cemetery, or any private or public premises infested with injurious insects or plant diseases, he shall notify the owner or person having charge of such premises to that effect, and the owner or person having charge of the premises shall within ten days after such notice cause the removal and destruction of such trees, plants, shrubs or other plant material if incapable of successful treatment; otherwise, cause them to be treated as the Board may direct. No damages shall be awarded to the owner for the loss of infested or infected trees, plants, shrubs or other plant material under this act.

(2) In case the owner or person in charge of such premises shall refuse or neglect to carry out the orders of the Board within ten days after receiving written notice, the Board may proceed to treat or destroy the infested or infected plants or plant material. The expense thereof shall be assessed, collected and enforced as taxes are assessed, collected and enforced against the premises upon which such expense was incurred. The amount of such expense when collected shall be paid to and become a part of the fund used to enforce the provisions of (this act) (sections —— to ——, inclusive).

Application for Inspection

Section 13.—Persons desiring to sell or ship nursery stock shall make application in writing before July 1st of each year to the Board for inspection of their stock. Persons failing to comply with this section shall be liable for extra charges to cover traveling expenses of the inspector.

Imported Stock

Section 14.—Every person receiving directly or indirectly any nursery stock from foreign countries shall notify the Board of the arrival of such shipment, the contents thereof and the name of the consignor; and shall hold such shipment unopened until duly inspected or released by the Board. In case any infested or infected stock is discovered in such shipment, the shipment shall be subject to the provisions of (this act) (sections —— to ——, inclusive).

Nursery Certificate

Section 15.—(1) The Board shall cause to be issued to owners of any nursery in the state after the stock has been officially inspected as previously provided, and found to be apparently free from injurious insects or plant diseases, a certificate signed by the inspector setting forth the fact of such inspection and the number of acres or fraction thereof inspected. Said certificate shall be valid not to exceed one year from (month) 1st.

(2) It shall be unlawful for any person to sell, to offer for sale or to remove or ship from a nursery or other premises, any nursery stock unless such stock has been officially inspected and a certificate or permit has been granted by the Board.

Dealer's Certificate

Section 16.—All dealers within the meaning of this act, located either within or without the state, engaged in selling nursery stock in this state or soliciting orders for nursery stock within this state, shall secure a dealer's certificate by furnishing a sworn affidavit that he will buy and sell only stock which has been duly inspected and certified by an official state inspector; and that he will maintain with the Board a list of all sources from which he secures his stock.

Certificates to Firms Outside the State

Section 17.—Nurserymen, dealers or other persons residing or doing business outside the state desiring to solicit orders for nursery stock in the state shall, upon filing a certified copy of their original state certificate with the Board obtain a certificate permitting such persons to solicit orders for nursery stock in this state.

Agent's Certificate

Section 18.—All agents within the meaning of this act selling nursery stock or soliciting orders for nursery stock for any nurseryman or dealer located within the state or outside the state, shall be required to secure and carry an agent's certificate bearing a copy of the certificate held by the principal. Said agent's certificate shall be issued only by the Board to agents authorized by their principal or upon request of their principal. Names and addresses of such agents shall not be divulged by the inspector or the Board.

Section 19.—The Board shall at any time have the power to revoke any certificate for sufficient cause, including any violation of (this act) (sections —— to ——, inclusive) or non-conformity with any rule or regulation promulgated under (this act) (sections —— to ——, inclusive).

Misrepresentation of Stock

Section 20.—(1) It shall be unlawful for any person to wilfully misrepresent to any other person the grade, character, variety, or quality of stock in a nursery, or of stock offered for sale by any nurseryman, dealer, or agent, or to make a false declaration of acreage or to cause any concealment of stock from inspection.

(2) Every person selling nursery stock in the state shall, if requested, furnish the Board with copies of his order forms, contracts and agreements with his customers, which are furnished for the use of agents or customers or both.

Certificate Shipping Tags

Section 21.—Every person who shall engage in the selling and shipping of nursery stock in the state is hereby required to attach on the outside of each package, box, bale, or carload lot so shipped or otherwise delivered, a tag or poster on which shall appear an exact copy of his valid certificate. The use of tags or posters bearing an invalid or altered certificate and the misuse of any valid certificate tag is hereby prohibited.

Section 22.—It shall be unlawful for any person to accept for shipment any nursery stock without a valid certificate plainly affixed on the outside of the package, bale, box or car containing the same, showing that the contents have been duly inspected

by an official state or federal inspector. In case any nursery stock is shipped in this state, or into this state from another state, country or province, without the aforesaid valid certificate plainly affixed, the fact must be promptly reported to the Board by the person carrying the same, stating the consignor and the consignee and the nature of the shipment.

Appeal

Section 23.—(1) Any person in interest or affected by any order of the Board or inspector may appeal therefrom to the Board within five days of the service of such order upon him setting forth in writing specifically and in full detail the order on which a hearing is desired, and every reason why such order is deemed to be unreasonable.

(2) On receipt of such appeal the Board shall with reasonable promptness order a hearing thereon and consider and determine the matters in question. Notice of the time and place of hearing shall be given to the petitioner and to such other persons as the Board may direct. Such appeal shall not suspend the operation of the order appealed from unless so ordered by said Board. All hearings of the Board shall be open to the public.

Section 24.—Compensation of inspector or deputy inspectors (a local matter).

Penalty for Violations

Section 25.—Any person violating (any section of this act) (any one or more of sections —— to ——, inclusive) or any rule or regulation promulgated under this act, shall be guilty of a misdemeanor and on conviction thereof shall be fined the sum of not less than $25.00 nor more than $500.00 for each offense.

Section 26.—It shall be the duty of each (District Attorney) (County Attorney) to whom the Board shall present satisfactory evidence of violation of any provision of (this act) (sections —— to ——, inclusive) to prosecute without delay such violations in the proper court.

Section 27.—Appropriations, fees, gifts or other support of the horticultural inspection service (a local matter).

Section 28.—(This act) (sections —— to ——, inclusive) shall take effect and be in force from and after [passage and approval (and publication)] (date).

FOREIGN PESTS RECENTLY ESTABLISHED IN NEW JERSEY

By Harry B. Weiss, *New Brunswick, N. J.*

During the past couple of years, the following insects were found to be established in varying numbers in different parts of New Jersey. Practically all were introduced on imported nursery stock and their presence is an indication of the impossibility of hoping to keep out all foreign pests by a system of inspection. Insect importations and subsequent establishments will undoubtedly continue just as long as nursery stock is imported inasmuch as the protection afforded by inspection is necessarily only partial and sometimes ineffective depend-

ing as it does on the experience, ability and carefulness of the inspector and the impossibility of closely examining every individual plant.

Lepidoptera

Gracilaria zachrysa Meyrick has been found in greenhouses in northern New Jersey, the larvæ of which turn over the tips and edges of azalea leaves and feed therein, causing them to turn black and die. This species has also been taken in the larval and pupal stages on azaleas imported from Belgium and was evidently introduced from that country. *Evetria buoliana* Shiff., which is the well-known, destructive European pine-shoot moth on whose account the further importation of pines from Europe has been prohibited, is also established in New Jersey.

Orthoptera

In this order we have *Gryllotalpa gryllotalpa* L., the European mole cricket to which numerous European writings refer as a troublesome pest. The party on whose premises it was discovered claims to have destroyed at least 20,000 including eggs. This insect undoubtedly came over in the soil around plants from Holland or Belgium or both of these countries and the impossibility of thoroughly inspecting soil in such conditions is self evident.

Coleoptera

In this group we have *Otiorhynchus sulcatus* Fab., long established in this country, suddenly becoming quite active as a rhododendron pest in several parts of the state. *Agrilus viridis* L. var. *fagi* Ratz., which does considerable damage to standard and *Rugosa* roses, is another foreign beetle which is prevalent in New Jersey. Still another and much more injurious beetle, especially to Scotch fir, is *Myelophilus piniperda* L., which as far as is known has only a slight foothold in the state. *Plagiodera versicolora* Laicharting, which is an old name for the common *P. armoricæ* of Europe, was found during the last two summers injuring poplars and willows at Arlington, Elizabeth and Irvington. Both the larval and adult stages feed on the foliage and do considerable damage. This species is firmly established in New Jersey.

Diptera

This order is represented by *Phytomyza aquifolii* Gour., lately found mining the leaves of English holly and also taken on holly imported from Europe (Holland), by *Merodon equestris* L., known as the narcissus fly, which was evidently introduced in bulbs from Holland where it does considerable damage, and by *Monarthropalpus*

buxi Lab., the box leaf miner, recently found injuring boxwood on private estates and taken at various times on boxwood from Holland.

Homoptera

This group contains eight species, four of which were found established on outside stock and four on greenhouse plants. The four on outside stock came originally from Japan and are *Antonina crawi* Ckll., the cottony bamboo scale on bamboo, *Leucaspis bambusæ* Kuwana, another scale insect on bamboo, *Aspidiotus tsugæ* Marlatt on Japanese hemlock and *Pseudococcus kraunhiæ* Kuwana, a mealy bug on *Taxus cuspidata brevifolia*. Three of the greenhouse species are coccids which were found infesting orchids. These are *Targionia biformis* Ckll., from Brazil and Venezuela, *Chrysomphalus perseæ* Comst., from Guatemala, and *Chrysomphalus rossi* Mask., from the Philippine Islands. The other is a species of white fly (*Aleyrodes* sp.) which is continually being introduced into New Jersey greenhouses on azaleas from Belgium.

It must be understood, of course, that we are not idle after an infestation is found and steps are always taken if possible to exterminate it or to prevent its spread. Unfortunately, however, this is not always practical, due to the favorable surroundings of the infestation or ignorance of its existence until considerable damage has been done. Thus the burden of the entomologist is increased by additional correspondence, additional insect pests to combat and the necessity of obtaining additional funds for that purpose or stretching an already meager appropriation to cover it, to say nothing of the damage which many foreign insects are capable of doing.

What is occurring in New Jersey must to a certain extent be happening in other states, dependent, of course, on the amount of imported stock received. During the year 1914, 11,742 cases of nursery stock came into New Jersey from Europe and South America and during the spring of 1915, 5,405 cases were received. New Jersey, therefore, is in greater danger from foreign pests than most other states, but once established there, a natural spread to other states would finally take place. These recently found foreign pests established in New Jersey are not by any means the result of a laxity in the inspection service, as every precaution is taken that our funds will permit. In most cases they are insects which have entered undetected by the inspector, sometimes through his ignorance of foreign pests, sometimes on account of individual carelessness, but mostly on account of the impossibility of examining every leaf, twig, root and particle of soil around the roots of a plant and having anything left that will grow, especially when one is called upon to inspect hundreds of plants every

day. In other words, ordinary inspection will not keep out all foreign pests and extraordinary inspection would not be tolerated by importing firms or paid for by state governments. Therefore the only other way in which the danger from foreign insects can be reduced to a minimum is by a federal law prohibiting the importation of all nursery stock. This was suggested at last year's meeting of this body.

In order to determine how such a ruling would be received by New Jersey importers of nursery stock, most of them were interviewed along this line during the course of inspection work the past year and the majority were in favor of it or indifferent. This opinion, however, applies only to the importation of ornamental stock as very few imported fruit stocks enter New Jersey and very little fruit stock is grown. Their reasons for favoring such a measure were not by any means entomological but purely commercial. Some of the firms interviewed have built up organizations capable of growing their own stock and are therefore to a certain extent independent of foreign growers. Many said that they were forced to import certain plants because everybody else did and that they could not afford to stop even though the profit in such plants was small. Others complained of foreign shippers who, after supplying the regular trade, unloaded stock on the auction houses where it was sold considerably cheaper than they could import it for thereby making it possible for "fly by night" nurserymen and firms with no overhead charges to sell cheaper than they. Others spoke of the inferior goods imported by some department stores and sold to the unsuspecting public, a procedure which no reliable nursery firm could afford. Others were indifferent as long as all firms alike would be prohibited from importing stock.

All were agreed in that the sale of native plants would be accelerated, that the prices of certain plants would advance due to increased expense in growing them and that stock which could not be grown here on account of adverse climatic conditions, labor, poor soil, etc., the public would simply have to do without or take a substitute, also that it would be impossible to obtain plant novelties or new things.

The minority in favor of importations being continued consisted of firms not equipped to grow certain kinds of stock, department stores, men who depended upon auction houses for their supply of imported plants, and others who have been making a profit by importing and reselling stock. Thus, whether an importer was in favor of or against further importations hinged upon—would he lose money, could he grow the stock here profitably, could he grow something else to take its place? It is to be regretted, of course, that some persons would be seriously handicapped if further importation was prohibited, but

the main issue is—will the interests of the state be served best by imported nursery stock plus foreign pests or by no imported stock and no pests?

Since writing the above, two additional foreign species established in New Jersey have been identified. One of these is *Eucactophagus graphipterus* Champion, a weevil whose larva lives in soft bulbed orchids and is capable of doing considerable damage to such greenhouse stock. This came to us in orchid stock from Central America or the U. S. of Colombia. The other is a Tingitid from Japan, namely *Stephanitis azaleæ* Horv., which did considerable damage to hardy azaleas in various parts of the state during the past season, and which appears to be firmly entrenched. This species was introduced with azaleas imported directy from Japan and escaped detection until it had established itself over the entire state.

In closing I wish to express my indebtedness to the various specialists in the U. S. Bureau of Entomology, who through the courtesy of Dr. L. O. Howard identified many of the species mentioned.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1915

By E. R. Sasscer

The condition of nursery stock offered for entry has unquestionably shown a marked improvement since the passage of the Plant Quarantine Act in 1912. This condition cannot be attributed to a falling off of importations during the present year, for, as shown in the accompanying table, the European exportations for 1915 exceed those of 1913 and 1914.

Table Showing Increase of Nursery Stock Offered for Entry During the Past Three Years

	1913		1914		1915	
	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds	Nursery Stock	Seed, Pounds
Belgium	704,927		720,891	165,000	1,114,089	
England	2,578,174		2,267,285		3,914,901	
France	30,812,059		29,024,187	2,073	41,604,161	40,053 [illegible]
Germany	1,360,398	7,020	194,186	1,049	177,994	821 [illegible]
Holland	5,274,944		4,602,954		6,539,416	6

In spite of the increased European importations and the unsettled condition of the countries which export in bulk to the United States, nursery stock, for the most part, has been comparatively free from injurious insects during the current year. It is obvious, therefore,

that the Plant Quarantine Act, in addition to offering many advantages to the state inspectors, has, furthermore, indirectly served the purpose of strengthening the inspection service of foreign countries. However, undesirable insects continue to enter on imported plants and plant products, but the number is infinitesimal as compared with former years. Instead of collecting brown-tail nests and gipsy moth egg masses by the hundreds, they are now intercepted only on rare occasions and in limited numbers. This scarcity of recognized pests does not indicate that there are not others of equal importance, which should be kept out, and careful examination of all foreign stock should be continued with vigilance.

Unfortunately, there still appears to be a lack of funds in certain states to properly conduct the inspection of foreign plants, with the result that many small shipments, especially those containing florists' stock, are not examined. The repeated finding of gipsy moth egg clusters on azaleas would seem to justify a careful inspection of all imported field-grown plants. In view of the fact that letters of information listing all reported interceptions have been placed at the disposal of the inspectors at intervals throughout the year, only those pests which appear important will be briefly referred to at this time.

Seven nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) have been collected on French nursery stock, and one nest on rose from Irleand. Egg clusters of the gipsy moth (*Porthetria dispar* Linn.) were taken on six shipments as follows: three on azaleas from Belgium; one on blue spruce from Holland; and two on cedar from Japan. No less than 1,105 larvæ of the European pine shoot moth (*Evetria buoliana* Schiffermiller) were detected on shipments of *Pinus mughus* and *P. montana* from Holland, and a single specimen of *E. resinella* was also taken on *P. mughus* from Holland.

A new species of *Tripopremnon* was collected in Irish potatoes from Peru. This is the fourth potato weevil [1] taken from Andean tubers, none of which are known to exist in the United States. Occurring as these insects do in the Andean region of South America, it is very probable that if once established in the States, these weevils may become a serious menace to the growing of Irish potatoes. Infested potatoes are riddled with galleries and rendered unfit for consumption.

Egg masses of the European tussock or vapourer moth (*Notolophus antiqua* Linn.) have continued to enter on various kinds of stock from France, Denmark, Holland, and England. A dagger moth (*Apatela auricoma* Fab.) has also been frequently reported on French nursery stock.

[1] Sasscer, E. R. and Pierce, W. D. [Proc. Entom. Soc. Wash., XV, 3, p. 143 (1913)]. Pierce, W. D. [Jn. Agric. Research I, p. 374 (1914)].

Orchids from Colombia and Venezuela have shown a slight infestation with *Tenthecoris bicolor* (Scott). The pine sawfly, *Diprion pini* (Linn.), was collected on four different occasions on *Pinus mughus*. This sawfly appears to rank as a pest of importance in Europe, and it would, no doubt, adapt itself readily to the conditions in America. A second sawfly, *Emphytus cinctus* (Linn.), has been collected in the stocks of roses from France. Cocoons of an undetermined sawfly have also been collected on spruce from Holland.

Banana plants from the Philippine Islands exhibited a severe infestation with the banana root-borer, *Sphenophorus* (*Cosmopolites*) *sordidus* Germ. When received, these plants were apparently healthy, but after remaining in quarantine for several months they commenced to die down, and on close examination the roots were found to be riddled by the larvæ of this banana borer. In addition to the banana borer, these plants were also infested with *Calandra remota* Sharp. Instances such as the above demonstrated the necessity of growing plants in quarantine where they can be under constant observation. As previously indicated, the plants when received were apparently healthy, and no external evidences of insect injury could be found.

Some 1,466 pear seedlings from France exhibited an infestation of the European pear scale, *Epidiaspis piricola* Del. G. This coccid is now established in a few of the states, but is not, as yet, well distributed, and an effort should be made to prevent its introduction and further dissemination. In addition to the pear scale, the following coccids have been collected on imported material.

Aonidia sp. on *Myrciaria edulis* from Brazil.
Aspidiotus palmæ Morg. & Ckll. on cocoanut from British Honduras.
Chrysomphalus perseæ (Comst.) on orchids from Venezuela and Guatemala.
Pseudaonidia articulatus (Morg.) on citrus cuttings from Philippine Islands.
Pseudaonidia pæoniæ (Ckll.) on azalea from Japan and Holland.
Targionia biformis (Ckll.) on orchids from Panama, Venezuela, and Brazil.
Chionaspis tegalensis Zehnt. on sugar cane from Java.
Chionaspis wistariæ Cooley on wistaria from Japan.
Lepidosaphes newsteadi (Sulc.) on *Sciadopitys verticillata* from Japan.
Leucaspis bambusæ Kuw. on bamboo from Japan.
Phenacaspis eugeniæ (Mask.) on ornamental plant from China.
Parlatoria theæ Ckll. on maple from Japan.
Parlatoria zizyphus (Lucas) on citrus cuttings from Philippine Islands. This scale is frequently collected on Mediterranean citrus fruits but is seldom detected on nursery stock.
Pinnaspis buxi (Bouché) on cocoanut from British Honduras.
Pseudococcus azaleæ (Tins.) on azalea from Japan.

In conclusion, it would seem opportune to raise the question of soil around the roots of plants, such as azaleas, rhododendrons, boxwood, etc. During the past year two insects, the European earwig

(*Forficula auricularia* Linn.), and the European mole cricket (*Gryllotalpa gryllotalpa* Linn.), have appeared as pests in the eastern states, which were, in all probability, introduced in soil around the roots of florists' stock. The former insect is now well established in Newport, R. I., and vicinity, and has been the subject of investigation by the Bureau of Entomology during the past season. In Europe this insect is not looked upon as a serious pest, and its depredations, in so far as injury to plants at Newport, have been comparatively negligible. However, its presence is objectionable, owing to the fact that the insects leave their shelter after dusk, often crawling over porches, and frequently, when frightened, seek shelter in the clothing of the occupants of the veranda. Furthermore, these insects crawl through the houses and conceal themselves under cushions, backs of chairs, closets, shoes, and, in fact, every conceivable place. The appearance of the European mole cricket in New Jersey was recently described by Mr. Harry B. Weiss.[1] As, in the case of the earwig, the mole cricket is not a serious pest in Europe, although at times it does occasion some injury to plants which happen to be in the line of the burrow of the insect. Elaterid and Lachnosterna larvæ have also been discovered in soil around imported stock. With such evidence as indicated above, does it not seem desirable to consider the question of soil around the roots? In other words, is it practicable to forward such stock without soil around the roots? In case this is not permissible, is there not a possibility of eliminating such soil pests by fumigating all imported material at the port of entry with hydrocyanic-acid gas in the presence of a partial vacuum.

INSPECTION FACILITIES IN THE DISTRICT OF COLUMBIA

By E. R. Sasscer.

Largely through the untiring efforts of the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, the much needed equipment for the inspection of imported nursery stock was installed during the current year. To emphasize the necessity of proper inspection facilities it will, perhaps, be well to briefly describe the nature of the material to be inspected.

The Office of Foreign Seed and Plant Introduction alone is constantly bringing in plants and plant products from all quarters of the globe, many of the packages originating in countries which have no system of inspection and of which we know little as regards insects and plant diseases. Although foreign official channels constitute an important

[1] Journal of Economic Entomology, Vol. VIII, No. 5, p. 500, 1915.

source from which new plants and plant products are imported, scores of packages are received from diplomatic and consular officials, botanical collectors, travelers, missionaries, and amateur plant lovers abroad. Moreover, the Office of Foreign Seed and Plant Introduction has its own trained agricultural explorers who travel through foreign countries studying the native flora and they secure and forward to this country such seeds and plants as seem promising. Other offices of the Department also import plants and plant products; for example, quantities of seeds and bulbs are brought in for congressional distribution. The office of Crop Physiology and Plant Breeding Investigations introduces new and promising citrus plants and seeds. The Offices of Cereal Investigations and Forage Crop Investigations bring in seeds of cereals and forage plants, and the Bureau of Forestry introduces tree seeds. In fact, it is safe to say that at one time or another practically every bureau of the Department of Agriculture introduces nursery stock of some description. It is obvious, therefore, that in order to properly inspect and safeguard such material adequate inspection facilities are essential. However, as a further protection many of the plants, after having passed the initial inspection, or after a definite period in quarantine, are grown at one of the four field stations maintained by the Office of Foreign Seed and Plant Introduction, and are again inspected at the time of distribution.

Method of Inspecting Imported Nursery Stock

No imported nursery stock is inspected until an inspection card has been prepared and placed with the unopened plants or plant products indicating the kind, quantity, and origin of the material, and, when possible, the proposed destination. Naturally, the latter is more or less dependent upon the findings of the pathological and entomological inspectors. In addition to the serial number assigned by the Office of Foreign Seed and Plant Introduction, each introduction receives a Federal Horticultural Board number, which is placed on the inspection cards. These numbers serve to identify the introduction at any time in the future and make immediately available all necessary information regarding its source, name, method of culture, etc., thus rendering it possible to have a connected history of the plants many years after their introduction.

Questionable seeds, cuttings, plants, buds, or bud sticks, or those harboring insects or diseases of any description, are either destroyed or subjected to disinfection and grown under observation in a specially screened quarantine greenhouse far removed from the area of cultivation.

Inspection House

The inspection house (Pl. 11, fig. 1) consists of an inspector's office and an inspection room. This house is enclosed by a high wire fence, and the gates and doors are always kept locked. Only those responsible for the proper conduct of the work are provided with keys. In special cases passes are issued to interested persons good for the day of issue only.

The inspector's office is 12 by 19 feet, and is provided with three windows, two skylights the entire width of the room, and three doors, one of which opens into the inspection room. Only such furniture as is necessary to care for the inspection records, etc., is kept in this office, and under no conditions is nursery stock inspected in this office.

The inspection room is 19 by 30 feet, and is provided with four windows, four skylights the entire width of the room, eight ventilators, and four doors, all of which are thoroughly screened with copper wire mesh (40 meshes to the inch). The floor and about three feet of the walls are made of concrete, the remainder of the walls being made of galvanized iron. It is possible, therefore, to thoroughly flush or syringe the floor and walls with water or a disinfectant without fear of damage.

The furnishings of the inspection room consist of five white enameled tables on wheels on which is placed the material for inspection, four white enameled stools, three white enameled refrigerators (used to safeguard perishable material), a small sterilizer, a stove, a sink for washing the hands, scales, and white enameled trays for sterilizing small quantities of seed, cuttings, etc., with bichloride of mercury, and one white enameled bucket containing a weak solution of bichloride of mercury for washing the hands after handling suspicious material. Long white coats are always worn when inspecting material. Soiled coats are kept in a galvanized iron bucket until they have been thoroughly disinfected and laundered. The inspection room is cleaned daily and fumigated or washed down with formaldehyde as the occasion demands. (See Plate 12.)

The quarantine greenhouse is 70 feet long by 20 feet wide, and is divided into 14 units, six of which are 14 feet by 7 feet four inches, and eight of which are 7 feet 8 inches by 7 feet four inches. A three-foot corridor extends the entire length of the structure. To enter a unit from the corridor it is necessary to pass through a vestibule 3 feet by 3 feet which is provided with two doors, one opening into the corridor and the other into the unit. All doors and ventilators are thoroughly screened with the copper wire previously described. The ventilators are so arranged that they can be controlled from the corridor, thus

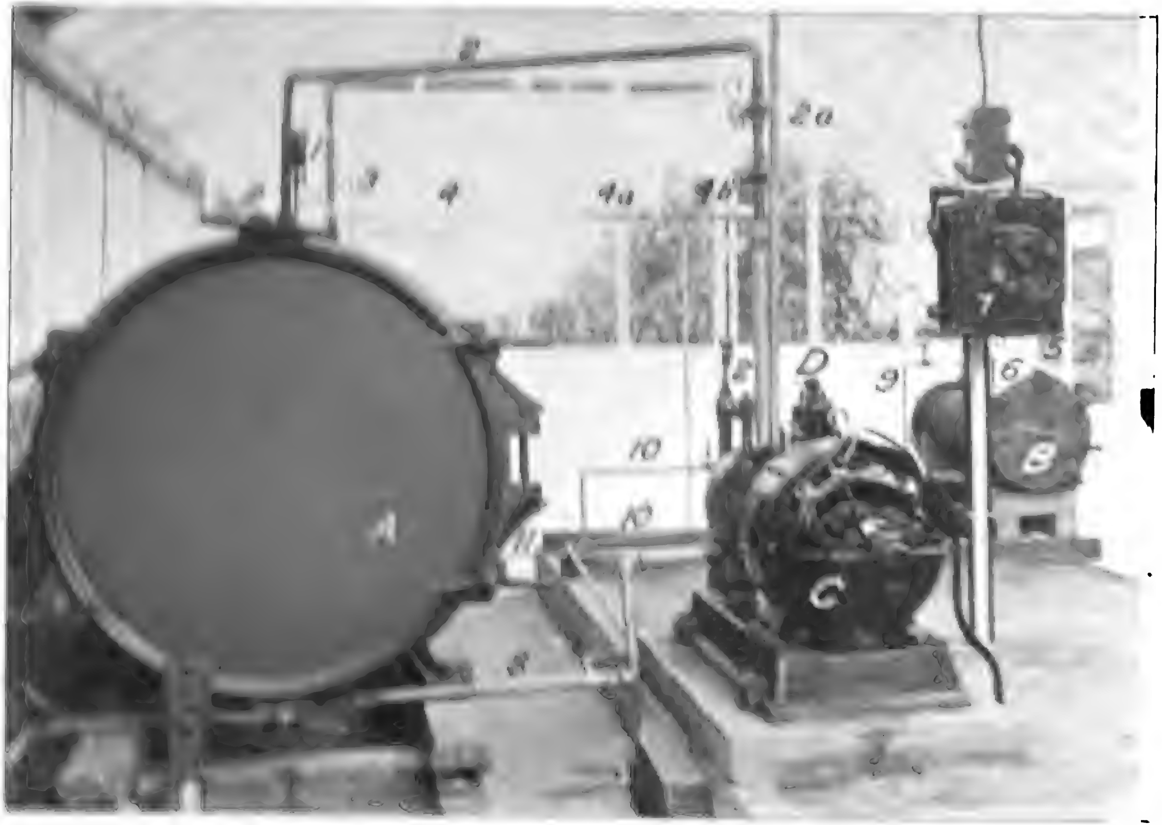
obviating the necessity of entering the units to adjust the ventilators. Furthermore, the ventilators, in addition to being screened, open into the corridor and not directly out of doors, thus reducing to a minimum the possibility of a wind storm injuring the plants or permitting the escape of insects by blowing off the opened ventilators of the units. The corridor is ventilated at the apex of the room by the usual type of ventilators used on greenhouses. To secure proper circulation each unit is also provided with a small sliding window 10 inches by 16 inches thoroughly screened with copper wire mesh. The sill of each window is eight inches from the floor. These units are so arranged that any one can be fumigated independent of the others.

A record of the contents of each unit is suspended near the outside of the door entering the vestibule of each unit from the corridor. This record indicates the Federal Horticultural Board number, date of quarantine, name of plant or plants, origin, object of quarantine, and prescribed treatment. Plants are not removed from a unit or new plants substituted without the approval of an inspector of the Federal Horticultural Board. Long white coats are used by anyone entering the units.

Two additional units, 14 by 20 feet and 18 by 20 feet, are maintained for the purpose of carrying material released from quarantine and awaiting orders for distribution.

Description of Apparatus Used for Sterilizing Plants and Plant Products

"Briefly, this apparatus consists of a fumigation chamber or retort [Plate 13] (A), an auxiliary chamber or generator (B) for the generation of the gas, and an air pump (C). An additional air pump (D) is also a part of this apparatus, although not necessary for fumigation. One end of the fumigation chamber or retort is permanently closed, while the other end is provided with a heavy iron door swung on a hinge and held in place by six clamps. The gasket which is embedded in the door comes in close contact with the flange of the retort, and when properly greased and clamped prevents air from entering the chamber during an exposure. This retort lies with its longest axis in a horizontal position. On the upper side of the retort there are four openings: The one nearest the door (1) is provided with a vacuum gauge, which registers the degrees in pressure in units equivalent to inches of mercury; the second opening (2) is fitted to an exhaust pipe which is attached to the air pump (C), the exhaust leaving the pump at 2*a*; the third opening (3) is used to permit the air to enter the chamber at the completion of an experiment, while the fourth opening (4) is fitted to a pipe which leads to the



Fumigating apparatus

Interior of inspection room. Sterilizing hands. See refrigerators, steam sterilizer, etc.

Inspection room, quarantine house and grounds

auxiliary tank or generator (B) in which the gas is generated. The pipe leading from the fourth opening to the auxiliary or generator is provided with a gas cock and three enlargements, 4*a*, 4*b*, and 4*c* (the latter is not shown in the photograph). Two of these enlargements contain sodium cyanide, and the third glass wool. The object of the sodium cyanide and glass wool is to pick up any free sulphuric acid which may be mechanically drawn from the generator when the gas is permitted to enter the fumigation chamber. The auxiliary or generator (B) is so arranged that it can be used as a generating tank or as a fumigating chamber, by closing the gas cock just above the cylinder. The exhaust pipe which leads from the generator to the small vacuum pump (D) is shown as figure 9. No. 5 is a tubulature used in introducing the chemicals into the generator. No. 8 is a pipe which carries water to cool the air pump (C), and No. 10 is the cooling pipe for the small air pump (D). No. 11 is the pipe which carries the exhaust from the small air pump, and No. 6 is a combination pressure and vacuum gauge. No. 7 is a rheostat.

The material to be fumigated is placed in the retort (A), the door closed and clamped, and the air exhausted until the gauge registers about 26 inches; that is, the air in the chamber is exhausted until the pressure is the equivalent of about 5 inches of mercury. At this stage the suction is cut off, and the gas is generated in the auxiliary chamber (B) and introduced into the fumigation chamber through the pipe (4). The gas may be generated in one of two ways. The cyanide may be placed in the jar within the generator, the door closed, and the acid and water introduced through the tubulature (5), or the acid may be placed in the jar within the generator and the cyanide in solution introduced through the tubulature (5). The latter method is preferable, especially where a glass tubulature is employed, as it eliminates all possibility of breakage of glass by the heat generated from the combination acid and water. In fact, to prevent breakage, it has been found advisable to cool the acid and water, which reduces the yield of gas. Where the cyanide in solution is introduced through the tubulature, no heat is generated until the solution comes in contact with the acid in the generator. This method has an additional advantage in that the yield of gas is increased."

The material to be disinfected may be fumigated in either of two ways, namely, by generating the gas in the presence of a partial vacuum and holding the vacuum for a definite period, or by generating the gas in the presence of a partial vacuum and returning to normal atmospheric pressure upon the completion of the generation.

NURSERY INSPECTION IN FLORIDA

By F. M. O'Byrne

To the ordinary observer the present nursery inspection requirements in Florida may seem to be far fetched and over exacting. But they are but the logical outgrowth of a trying experience through which we are now passing and each step has been necessitated by some actual and costly experience.

It will not be possible in the short time at my disposal to more than mention the steps which have led us to our present position. Quite briefly they are as follows. In the years of 1911–12 there were imported into the state of Florida over 35,000 diseased citrus seedlings. These came from a nursery in another state, which nursery had been inspected and certified as apparently free from especially injurious insect pests and diseases. This is no reflection on the other state, for this disease was new to them and had not as yet been recognized as a new disease but was thought to be an unusual form of an old, well-known malady.

This new disease was especially virulent on grape-fruit trees. The nursery first found to be infected had many branches in the state. These branches were grouped under two separate managements. The particular branch showing the disease was placed under quarantine but shipments proceeded from the other branches. Somewhat later another branch controlled by the same management was found to be diseased. It was immediately quarantined but still shipment proceeded from four other branches. We did not know, as yet, that this disease was dreadfully and terribly infectious and could be carried on the hands or clothing of an inspector or workman. Nor did we know, as yet, that under certain conditions the disease could apparently remain dormant on infected trees for a year or more before becoming visible to an inspector. The nurseries always claimed that they had been exercising every care to protect the other branches from becoming infected and the department, especially in the light of the weak law under which they were working, did not feel that they could quarantine a branch which was widely separated from the others and worked largely by a separate crew of men, until that particular branch showed signs of the disease. One after another, each of these branches showed the disease and in August of 1915, this malady was discovered in their last apparently unaffected branch.

It was learned that trees in certain of these shipments had developed the disease and, as it was the intention of the authorities to erad-

icate the trouble, it became necessary to ask the nursery concern to prepare an accurate list of all the shipments which they had made since the original discovery of the trouble, that they could be traced down and inspected. These nursery concerns were facing a grave crisis, income was cut off and expenses soaring, so that they were laying off all of the help they could. Naturally they were slow in preparing these lists of shipments and many inaccuracies were found to occur. As a result, the work of inspection was retarded and hampered severely. Suppose that these nurseries had gone bankrupt and the proprietors refused to prepare such a list, or suppose that a fire had destroyed their invoices, the result would have been terrible. We would have then been helpless and would probably have had this disease fastened upon us forever.

As a result of the foregoing experience, we learned that we should have on file in the office of the Nursery Inspector, an accurate record of the movement of each and every plant that could be classed as nursery stock, whether moving into from without the state or merely moving from place to place within the state, whether grown by a nurseryman or a person not regularly in the business, whether sold, given away or merely moved from one piece of property to the other by the owner. The question was to evolve a system that was iron-clad, easy of enforcement and not too burdensome on the nursery. The system adopted follows:

Each person who wishes to move any nursery stock in Florida shall apply to the Nursery Inspector for inspection. If the stock is found to be sufficiently clean a certificate is made out covering the stock inspected. This certificate is filed in the office of the Nursery Inspector, and the owner of the stock is privileged to purchase, through the Nursery Inspector, certificate tags bearing practically the same wording as the Certificate of Inspection.

One, and only one, of these tags must be attached to each and every package of nursery stock shipped. They are consecutively numbered and a record is kept of the numbers furnished to each and every person or firm, who are required to account for every tag they received, giving the name and address of the purchaser of the bundle of stock upon which a tag is used, the name and address of the person to whom shipped, and an exact description of the contents together with the number of the certificate tag used thereon. To do this they merely make out their invoices in triplicate instead of in duplicate as heretofore. This invoice shows the number of the certificate tag used on the shipment and one of the copies is sent to the office of the Nursery Inspector for permanent filing. Shipments of nursery stock which do not meet these requirements are illegal.

Nurseries without the state are allowed to purchase such tags upon the filing in our office of a satisfactory Certificate of Inspection. In all other respects they must meet the requirements imposed upon our own nurserymen.

Formerly, many of the nurseries were in the habit of soliciting club orders or of shipping to agents for redistribution. This defeats the end for which we are working. It was therefore necessary to require that such orders be packed individually and so billed and tagged. Then, if the nursery so desires, they may pack all of these small orders into one large one and ship to one person for redistribution. By so doing, we have in our office a complete record of the final destination of all such orders.

As has been said, we have been dealing with a new disease, which was at first mistaken for a peculiar form of an old well-known disease. Before we learned that it was very infectious, our inspectors undoubtedly spread the trouble while making inspections. This will never do. We must not lay ourselves liable to such a damaging charge again. But we do not know at what time another new disease may appear. Therefore the only safe course is to treat each nursery that we are inspecting, as if it contained some new and highly infectious disease. We therefore require each inspector to wear an inspection suit while inspecting a nursery. These suits are made of musaline, in one piece, and cover the entire body like a surgeon's operating suit. When an inspector finishes inspecting a nursery he removes the suit and sterilizes it completely by immersing it in 1 to 1,000 corrosive sublimate solution. He also sterilizes his hat, face, hands, and feet regardless of the condition in which the nursery was found to be. In order that the inspector may have a suitable vessel in which to mix the solution, they are each provided with a folding canvas bucket.

Failure to sterilize immediately on leaving a nursery makes an inspector liable to discharge.

The foregoing is but a rough outline of our system and of necessity omits many details. I would, of course, be glad to answer any questions. Our whole system may be summed up as follows: We aim to have a system of checking so that we may verify the statement of each inspector or nurseryman. We also must have a plain and accurate record of the movement of each piece of nursery stock planted in the state. The invoices, we require, provide a permanent and accurate record whereby we may trace the movement of all stock emanating from every nursery in the state. Should a new disease develop we have *instantly* at our command a record of shipments made from any diseased nursery so that diseased stock may be traced down and destroyed or quarantined.

THE OHIO INSPECTION SYSTEM

By N. E. Shaw, *Columbus, O.*

Entomological work in Ohio, under state control, is placed with three separate departments each having well defined duties to perform. All research work is done by the Entomological Department of the Experiment Station at Wooster; all instructional work in entomology comes under the Zoölogical Department at the University and the enforcement of inspection laws relating to insect control is placed with the Bureau of Nursery and Orchard Inspection of the Board of Agriculture.

A definite understanding as to the duties of each Division exists among the different heads yet there is coöperation of effort on all problems which concern alike the several divisions and when best results can be obtained by a combination of effort.

Nursery and orchard inspection work has existed as a separate Bureau since 1902 when the work was separated from the entomological work at the Experiment Station and placed under the direction of Mr. A. F. Burgess. The foundation of the inspection system which we are following today, with but slight changes, was prepared by Mr. Burgess.

Our law provides for the annual inspection of nurseries and as many additional inspections as may be thought necessary. This work is commenced about July 1, of each year, and a careful examination of the different nurseries is made row by row. With the consent of the nurseryman all stocks showing infestation by San José scale are broken over by the inspector and are promptly removed from the blocks by the nurseryman and burned. Should he object to the destruction of infested trees, he has the privilege under the Ohio law to apply such treatment as may be ordered. After this work has been complied with he again applies for the inspection of his nursery. He is permitted by provisions of the law to dispose of, within the state and with the consent of the purchaser, scale-marked nursery stock after treatment has been applied and the stock has been officially fumigated. But few nurserymen have ever availed themselves of this provision. The great majority of them prefer to have all infested stocks found by inspectors broken and removed from the blocks.

Where infested blocks have been found one or two additional inspections are made before shipping time, certificates are issued and the stock is fumigated under the supervision of inspectors and allowed to go out to the trade. Additional inspections are made of stock at digging time, either as it is lifted in the field or when

brought to the packing grounds to be fumigated. By these several inspections we endeavor to locate all infested trees, and then take the extra precaution of supervising fumigation work.

An inspection is also made during the summer of premises adjacent to blocks of nursery stock and treatment of infested trees is required so far as practical and where there is danger, by the location of infested trees, of their being a source of infestation to nursery blocks. An inspection is again made of these premises during the dormant period and a thorough spraying is enforced. Should owners neglect to apply this treatment in specified time, the work is done under the supervision of inspectors and the costs placed upon the tax duplicate of the owner.

Several hundred dollars worth of this kind of work has often been done under our supervision around different nurseries.

We have never strongly favored, except under unusual conditions and in extreme cases, the summer treatment of nursery blocks. With a slight infestation we prefer to carefully inspect and re-inspect such blocks, remove all infested trees and rely upon our fumigation system for the protection of the purchaser.

When fumigation work is left to the nurseryman at least one and quite often all of the essentials necessary in thorough fumigation are liable to be overlooked and disregarded. There are a number of things which will prevent even the most careful and conscientious nurseryman from performing this work as it should be done for best results. I feel sure that Mr. Burgess in his work in Ohio early realized the necessity for official supervision of this work. It was no easy task to get our nurserymen accustomed to this plan. When first adopted it caused considerable delay to the nurserymen while waiting for inspectors to supervise the work. After the system became well organized and the nurserymen had become accustomed to the practice, it was carried out with but little delay to them. Such work is made easily possible in Ohio by the excellent transportation system of the state and largely by the fact that our larger nurseries are grouped in several sections of the state. One or more inspectors are located in each section. Nurserymen keep them advised by phone of probable time that they will be needed and in this way they can plan their work and render prompt service. One inspector can usually take care of those scattered about the state.

Before the shipping season begins, nurserymen are required to go over their fumigating houses carefully and put them in perfect order. Inspectors then test each house with smoke and refuse to use any that have not been made perfectly gas tight. We often find that a house gets out of repair during the shipping season and it is immediately ordered placed in condition. The weakness, of course, is usually at

the doors and when continually used it is necessary to watch them closely.

The arrangement of stock in a fumigator so that it will be thoroughly exposed to the gas is not easily controlled.

Most of the larger nurserymen arrange to drive a wagon load of stock into the house. This allows in our judgment of very good exposure to the gas because the stock is well above the floor and the gas can easily penetrate to all parts of it.

Where stock is unloaded and placed in the house there is a tendency on the part of the nurserymen to want to pack it too tightly, often placing the roots on portions of the stems or trunks so that they are covered and the gas may not have free access to the insects. We insist upon an open floor usually built on two by fours or two by sixes so that gas can thoroughly reach the stock from below. It is necessary once or twice during a shipping season to take out these floors, which are usually built in sections, and remove the dirt which has shaken off from the roots and has accumulated until it fills up the open space below floor level.

We found, before supervision of this work was taken up, that the time required for the exposure was often cut in two and sometimes stock had been exposed but ten or fifteen minutes before opening the house. This is a frequent temptation when rush orders are received and cars are waiting to be loaded.

It was early found that potassium cyanide being secured by nurserymen in their several localities varied considerably in purity. In some tests that were made the per cent of potassium cyanide varied from 31.05 to 100. The practice was then inaugurated of having nurserymen place their orders through our office where this material could be secured from sources on which we could have some check and know that the proper grade was being sent out. Supervision of this work has also permitted us to know that potassium cyanide after being received by the nurserymen was kept in such a manner that it could not deteriorate. Even with this precaution we have occasionally secured inferior lots of potassium cyanide. Last year when a greater scarcity of this material was evident, we found that several shipments of the inferior grades had been made to nurserymen and it was necessary to refuse its use. During the present year we have used nothing but sodium cyanide.

This, in general, is an outline of the way in which we are handling nursery inspection and fumigation in Ohio. We are not always able to carry it out as thoroughly as we would like to do. Every inspector knows of the different things which arise to interfere with the best laid plans. It must be remembered that during a portion of the time

devoted to this work we are receiving large quantities of imported shipments of nursery stock from abroad which we feel must be given very prompt and careful attention. We have also had for past two years a gypsy moth outbreak to contend with and this, of course, has necessitated strict attention.

San José scale is a well established pest in the state of Ohio. In three-fourths of the state or throughout the level portions, the infestation is general and it is the exception to find an orchard free from this insect. In the other portion of the state which is hilly, it is rarely that an orchard is found infested with San José scale, and in this section are located our largest commercial apple orchards. In the infested area are many localities and many orchards where scale is under perfect control and is causing no particular injury or loss. This is due to the extensive campaign which is being waged for the proper treatment of farm orchards for insect control.

Over 11,000 people attended our orchard demonstrations during the present year.

So far as Ohio is concerned, we would feel that we were giving our planters of Ohio grown nursery stock adequate protection by carefully supervising the fumigation of nursery stock, destroying those stocks which are more than slightly infested and thus possibly might be weakened from scale attack. It seems rather unreasonable, in view of conditions as we know them to exist in Ohio and in the eastern and central states as well, to require the wholesale destruction of infested stock. I do not mean to say that we should recede at all from our position of having nurserymen use every precaution to protect their stock from infestation. The fact that our nurserymen have not taken advantage of the Ohio provision allowing them to dispose of scale marked stock within the state, would indicate that they are not inclined to take any backward steps in fighting San José scale.

We would feel perfectly safe in accepting from other states, stocks which would be given the same careful fumigation treatment that we are attempting to carry out in Ohio. We would feel that purchasers of nursery stock in this state were getting better protection than they are under present methods, as indicated by our findings this year.

At four of our nurseries receiving stock from nurseries located in seven other states within a radius of 400 miles and less of Ohio, we have found over 30,000 stock infested with San José scale and infected by crown gall in about equal numbers. In one shipment of 70,000 trees the infested and infected trees amounted to 15 per cent of the entire shipment. Bear in mind that these findings were made at four of our nurseries. If it were possible to inspect the vast quantities of stock which came into the state through agents and dealers, the count would be much larger. These inspections of incoming stock at the

nurseries are of course made for the protection of our nurserymen and our own certificate in order that when some of the same stock is again re-shipped back into the states from whence it came, we may possibly be relieved of the embarrassment of receiving a notice of an infested shipment.

I do not wish to give the impression by what has been said in the forepart of this paper that Ohio is not guilty of sending out infested or at least scale-marked stock. We know that we are because we have been told so and we like to have this information, when such shipments are made. One state has felt it necessary to send her inspector here to examine shipments of some large dealers from that state who secure and pack their stock here. That state happens to be one of the seven already mentioned and the distribution of San José scale is general throughout that state. We know this to be a fact because several of our inspectors have worked there in years gone by.

Here is what I feel that we should be doing in Ohio. Inspect carefully our nurseries and their surroundings, thoroughly fumigate their stock before it is disposed of and inspect every shipment of nursery stock entering the state. All of this seems necessary for the protection of our fruit-growing interests which our law was created to serve and for which funds are appropriated. What we are doing is spending the major part of our time in inspecting and re-inspecting our nursery stock in the field and on the packing grounds, inspecting stock which they receive from other states, all in order that the last insignificant little scale may be eliminated and our nurserymen's business be protected from injury by being discriminated against in some other state; giving our greatest efforts so far as Ohio is concerned to a relatively small number of men rather than our large number of commercial orchardists, owners of farm orchards and every citizen of the state who plants a tree or shrub.

I belive that inspection officials, in those states where San José scale is not a well established pest, are right in using the utmost care in preventing infested shipments from entering their states, but it does seem that a different attitude should prevail in those states where conditions are similar to those in Ohio.

THE STATE HORTICULTURAL INSPECTORS AND THE WHITE PINE BLISTER RUST PROBLEM

By Perley Spaulding

The white pine blister rust is a disease of five-leaved pines which was brought into this country from Europe some ten or fifteen years ago in imported lots of white pine seedlings. The parasitic fungus

causing this disease has an alternate stage of growth upon the leaves of wild and cultivated currants and gooseberries, that is, the genus Ribes. Ever since 1909, when the disease was first found in this country on pines, an effort has been made to eradicate this disease from this country because of the very serious danger with which it threatens our white pines. From 1909 to 1914, inclusive, there were eleven distinct cases where the disease spread from pines to neighboring Ribes, thus showing very emphatically the extreme danger of its becoming permanently established in this country. In some of these cases the disease also spread back to the neighboring pines from the infected Ribes, thus completing the entire life cycle of the parasite. In 1915, owing to the prolonged wet weather and accompanying winds, there were twelve such outbreaks of this disease. At present we have then a number of areas varying in size from a few acres up to an area in one case of some five hundred square miles, where the disease has spread upon Ribes and threatens to become permanently established. The disease cannot spread in any locality unless both kinds of hosts are present in that locality, that is, the removal of either one stops the spread of the disease.

The foresters of the white pine region have become thoroughly alarmed concerning the situation. It seems to be entirely practical to stop the spread of this disease in these infected localities by the mere removal of wild and cultivated Ribes within them and for some distance outside. This appears to be a far more practical procedure than that of the removal of gipsy and brown tail moths from trees up to 80 or 90 feet in height, which is being performed every year now in some sections.

In order to carry on this removal of Ribes, however, it is absolutely necessary that the horticultural inspectors of the various states shall have absolute power with which to compel uniform action on the part of the owners, if such uniform action cannot be otherwise secured. This matter is one which is sure to come to you within a very few years, and is even now staring some in the face.

Another matter which would go far toward reducing the danger from this disease is the quarantine of black currant, *Ribes nigrum*, so that it cannot be shipped from state to state. Such quarantine power also is important in preventing the shipment of white pines from one state to another. These two things every state horticultural inspector ought to try to have incorporated in his law, as he is sure sooner or later to find them necessary to his carrying on efficient work.

NOTES ON THE RELATION OF INSECTS TO THE SPREAD OF THE WILT DISEASE[1]

By H. W. Allen, *Gipsy Moth Laboratory, Melrose Highlands, Mass.*

During the caterpillar stages, vast numbers of the gipsy moth die of a disease known as the "wilt." This affection is typical of a group of insect diseases termed "wilt" or "polyhedral" diseases and which are characterized by extensive breaking down of the body tissue, and the formation of microscopic, angular bodies known as "polyhedra." Polyhedra invariably occur in large numbers in diseased insects and are considered to be reaction products. The disease is believed to be produced by infection of the alimentary canal and to be caused by a filterable virus, presumably an organism and very much smaller than the polyhedra.

Victims of the disease reach an advanced stage of disintegration soon after death. Dead caterpillars often occur in great abundance, and, as would be expected, attract many insect scavengers. Sarcophagidæ, in particular, are attracted in abundance and breed freely in the dead larvæ and pupæ resulting from the disease.

Very little is known of how the infection causing the disease is spread. Experiments by Glaser and Chapman[2] have indicated that it is not essentially a wind-borne disease. The presence of scavengers in connection with the disease suggested that they might be carriers of the infection and agents in the spread of the disease. It was believed that if these insects could be shown to be carriers of polyhedra, it would indicate that they might also be carriers of the virus and hence in all probability distributors of the disease. Accordingly, an effort was made to determine this in connection with other field work on the wilt disease conducted at Lunenburg, Mass., during the past summer. Although the work was preliminary, and not conclusive in indicating that the disease is insect-borne, it has shown that insects commonly act as carriers of polyhedral bodies and suggests that they also in all probability act as carriers and distributors of the disease.

In securing the record, specimens observed to have been in direct contact with gipsy moth larvæ and pupæ that had recently died as a result of the wilt disease, were collected in the field. These were sent to Messrs. Glaser and Chapman, of this Bureau, for examination and we are indebted to them for the findings in regard to polyhedra. Only such specimens were taken as were observed to have been

[1] Published by permission of the Chief of the U. S. Bureau of Entomology.

[2] Jour. of Economic Ent., Vol. VI, No. 6, pp. 479–488.

in contact with insects dead of the wilt. The active Sarcophagid flies, after leaving such material, were captured with a clean net and introduced into small, clean vials. Other, less active specimens were secured in glass vials after they had left a smear of wilt. The specimens were killed by placing the vials, plugged with clean cotton, in a cyanide jar. The *Calosoma sycophanta* larvæ taken, were removed from a mass of gipsy moth larvæ and pupæ which was moist with the fluid oozing from their dead bodies. Great care was used in collecting the specimens, so that they were secured bearing no more wilt contamination on their bodies than they would naturally carry when free and unmolested.

Polyhedra were found on a majority of the specimens captured. Feet and mouthparts especially were examined and both found to harbor polyhedra.

In collecting specimens, insect scavengers were most frequently found in contact with larvæ and pupæ dead of the wilt, and of these, certain Sarcophagidæ were by far the most abundant. Adult Sarcophagids were repeatedly observed walking over, feeding or depositing maggots on diseased material. They were often abundant in the treetops and on warm, bright days were very active, flying rapidly from leaf to leaf. They appeared early in May, and were abundant until the end of the pupal stage of the gipsy moth which terminates the epidemic of wilt. A number of Sarcophagid adults, found walking over or feeding on diseased material, were taken, and nearly all were found to be carrying polyhedra on their feet or mouthparts, or on both. Their abundance, the fact that they frequent wilt, that they are carriers of polyhedra, and are repeatedly found on the foliage upon which gipsy moth larvæ feed, all strongly suggests that the Sarcophagidæ do work of considerable importance in distributing the disease.

Other insects were occasionally observed in contact with the disease. Adult Elaterids were twice found feeding on gipsy larvæ that had died of the wilt, and on both occasions were found to carry polyhedra. Polyhedra were also found on two adult Coccinellidæ that were taken under similar circumstances. An unknown Hemipteron, and an unknown beetle larva taken wading through a fresh smear of wilt, and three *Calosoma sycophanta* larvæ captured in association with wilt material were all found to carry polyhedra. Polyhedra were also found to be carried by minute red mites. Ants were often observed on trees bearing the bodies of many larvæ and pupæ dead of the wilt. They occasionally fed on this material, but more commonly seemed to avoid it. The ants were collected several times and polyhedra were found once on an insect that had been captured crossing a dried smear of wilt.

Unfortunately a more specific determination of the insects found to be carriers of polyhedra cannot be given at this time. The nature of the experiment made it impracticable to determine the specimens until after they had been examined for polyhedra. After examination, many were badly mutilated, and owing to a misunderstanding were discarded. It is to be remembered that the work done was only preliminary and was planned to indicate whether insects ever acted as carriers of polyhedra. Now that it has been clearly shown that they commonly do carry polyhedra, it is expected to continue the work another season and among other things to determine more definitely the insects acting in that capacity.

To sum up, little is known of how the infection causing the wilt disease of the gipsy moth is distributed. It is evidently not primarily a wind-borne disease. Certain insects found abundantly in association with the disease, frequent the foliage of trees and are known to carry polyhedra after contact with the wilt, which indicates that they may assist in spreading the infection.

TWO NEW MONOPHLEBINE COCCIDÆ FROM THE PHILIPPINE ISLANDS

By T. D. A. Cockerell, *Boulder, Colorado.*

The Philippine Islands appear to be quite rich in Monophlebines; in addition to six species already recorded (all but one apparently endemic), the following two, received from Prof. C. F. Baker, must be described:

Llaveia benguetensis n. sp.

Male.—Length 4.5 mm., exclusive of abdominal processes; wings about 7 mm. long, black, with the usual venation and two hyaline lines; costal field dark reddish-brown; head and thorax black, the mesothorax shining, region just below wings dark red and dull; mesosternum enlarged, convex, polished black; eyes very prominent, constricted at base, placed at lower anterior corners of head; antennæ black, with very long black hairs; third joint with three nodes; legs black; abdomen broad, dark red, with the dorsal region strongly suffused with black, apex deeply emarginate; six long slender fleshy abdominal processes, the first pair shorter than the others, which are subequal, and are a little longer than the diameter of abdomen.

Hab.—Baguio, Benguet (Baker 5341). Resembles the Indian *L. stebbingi* (green), but is not at all dusted with mealy powder, and the distance between the second and third abdominal processes at base is very much greater. *L. fabricii* (Westwood), from Sumatra, is apparently, as Green remarks, another species of the same general type.

Drosicha palavanica n. sp.

Male.—Length about 3.5 mm., exclusive of abdominal processes; wings nearly 5 mm. long, black, with the usual venation and two hyaline lines; costal field dark

sepia; head and thorax dark red, front and mesothorax black; antennæ black, with long black hairs; third joint with three nodes; legs black; abdomen almost as broad as long, red, strongly suffused with blackish dorsally, with ten red fleshy processes, successively longer, each with long black hairs at end; the last processes are scarcely over one mm. long.

Hab.—P. Princesa, Palawan. The terminal caudal processes are much longer than in *D. maskelli* (Ckll.), but not so long as in *D. burmeisteri* (Westw.). Structurally, the species is like *D. leachii* (Westw.), but that is much larger. The male monophlebids now known from the Philippines may be tabulated thus:

Costal region broadly brilliant red; abdomen with six processes *L. sanguinea* Ckll.
Costal region not red...1
1. Abdomen with six processes.....................*L. benguetensis* Ckll.
Abdomen with eight processes.......................*L. luzonica* Ckll.
Abdomen with ten processes.....................*D. palavanica* Ckll.

In addition to these, I have specimens with eight abdominal processes, which are red, not plumbeous or blackish as in *L. luzonica*, from Mt. Makiling (Luzon.). Batuan (Mindanas), and Cuernos Mts. (Negros). These differ slightly from each other, and probably represent new species, but it is desirable to learn more about them. From Baguio (Benguat) comes a male *Icerya;* easily known from all the above by its small size (wings less than 3 mm. long), abdomen with long bristles, but without long fleshy processes. *Icerya candida* Ckll. and *I. seychellarum* (Westw.) are known from the Philippines in the female sex.

Three Important Insect Pests have appeared in Minnesota during the past season, two for the first time. The Hessian fly (*Mayetiola destructor*) was reported in the autumn of 1914 near Minneapolis. Prompt measures were taken for the suppression of this small outbreak, but a few "flaxseeds" were found this time near the University Farm in October, 1915. The last appearance of this insect in Minnesota was in 1903.

The Western corn root-worm (*Diabrotica longicornis*) has been reported in Minnesota for the first time during the past summer, appearing in several widely separated localities in the southern quarter of the state.

The corn root-louse (*Aphis maidi-radicis*) has also never been mentioned in any of the entomological reports of Minnesota. Last summer it caused extensive loss to corn in three widely separated localities in southern and south-western Minnesota.

C. W. Howard,
November 29, 1915. *University Farm, St. Paul, Minn.*

Labeling Parasite Material. Mr. Harry S. Smith, of Sacramento, Cal., noting my suggestion in the last Monthly Letter of the Bureau of Entomology in regard to labeling of parasites, suggests that where one is not absolutely certain of the host the label should be qualified in some way. He has adopted the plan of using the word "material." For example, if he has a box of scale insects of a certain species and rears parasites from it, he labels the parasites, say, "From *Saissetia oleæ* material." There are so many times a few individuals of some other species present but not visible that this is frequently a cause of erroneous records, and such a label as suggested immediately puts the parasitologist on his guard.

L. O. H.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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History has been made in the last few weeks. We now have a fully organized Pacific Slope Branch. If it was a good idea, it should be consummated at once, and after due consideration, we are convinced that the action taken will receive the hearty approval of the entire membership. In reality, the scope of the organization has not been extended. It amounts, in final analysis, to a practical recognition of the difficulties the western entomologist experiences in attending meetings in the east. We extend to our western confreres the right hand of fellowship. May the bonds strengthen as time passes.

Entomology becomes economic in proportion to the saving effected. The account of the Hessian fly train and the discussion of county coöperation against this pest are both striking examples of applied or economic entomology—the type that actually saves something. Knowledge applied is power; knowledge unused should be placed in the same category as the idle talent and may even be the occasion of merited rebuke. It does not follow that the entomologist without a special train, or the more or less general coöperation of a county, is remiss. He may be and we think most are accomplishing much in somewhat quieter ways. The extension entomologist, a term which has come into use within a few years, is a most useful individual and is able through specialization along one line to meet and show a very large number just how the best results can be secured. All entomologists must resort to such methods if they would secure

satisfactory results. It is largely a question of apportioning effort and here local conditions have an important bearing. The answer in no two cases will be exactly the same and the amount of time given to each line of effort must vary with the season and change more or less from year to year.

The training of the economic entomologist has received considerable attention at the hands of both teachers and workers. There is no question but that a liberal training with all that it implies is a most excellent foundation for a professional career. There are a number of related, special sciences of value to the entomologist and they likewise require close application for their mastery; not to mention the exacting requirements of entomology itself—a science dealing with an immense number of insects presenting extraordinarily wide variations in biology, ecology and adaptability. The well equipped entomologist should have several years of practical experience in both field and laboratory work, using the latter adjective in a somewhat general sense. This all takes time and it is doubtful if the best university undergraduate and graduate courses combined can cover all this ground in an entirely satisfactory manner. Furthermore, not every man can afford to devote the necessary time to cover the ground indicated above. In the ultimate analysis there must be more or less compromising on both sides of the line and, generally speaking, we believe that it is possible to cover only the broader, more fundamental phases in the university, leaving much of learning and most of the so essential practical experience with both insects and men (the latter by no means unimportant) to be gained by practise, preferably under the direction of one intimately acquainted with the many duties and privileges of the economic entomologist.

Tetranychus mytilaspidis Riley in New York: During the summer of 1915 a species of red spider was very abundant on apples and pears, growing on the grounds of the New York Experiment Station at Geneva. Specimens of the spiders were sent by Dr. H. Glasgow of this Department to Prof. H. E. Ewing of the Iowa Agricultural College for identification, who replied that the species was the Citrus Red Spider (*Tetranychus mytilaspidis*). This spider, according to Quayle (Cal. Bul. 234:487), occurs in Florida and California as a pest of citrus fruits. In Oregon it was observed by Ewing on plum, prune and other deciduous trees. As far as is known this is the first record of the occurrence of the pest in the eastern United States.

P. J. Parrott, *Department of Entomology,*
New York Agricultural Experiment Station, Geneva, N. Y.

Obituary

FRANCIS MARION WEBSTER

Economic entomology has suffered a severe loss in the sudden death, January 3, 1916, of Francis Marion Webster, head of the division of cereal and forage crop insect investigations in the United States Bureau of Entomology. He was attacked by pneumonia while in attendance upon the national scientific meetings held during the Christmas holidays at Columbus, O., and died of heart failure within four days.

His record as an entomologist is probably unparalleled in this country as an example of unusual success and usefulness won against heavy initial handicaps. Born in New Hampshire in 1849, he came, when four years of age, with his parents to De Kalb county in northern Illinois, where he passed his boyhood on a farm. The death of his father when he was fifteen years old left him largely to his own resources, and he had little formal education. Marrying at twenty-one years of age, he supported himself by manual labor in the town of Sandwich for a few years, after which he bought a farm in his home county, and lived there for the eight years following. A native bent for the observation of nature had inclined him to the collection and study of insects, especially Coleoptera, in which he developed an interest and enthusiasm which led him, in the fall of 1881, to seek for an opportunity to devote his life to entomology. "There are but two ways of becoming a naturalist," he wrote, "one, to cheat yourself out of sleep and Sundays, which is the way I have been doing for ten years, and the other, getting scientific employment, as I wish to do now."

He had already begun to publish brief papers on insects in the *Prairie Farmer*, of Chicago (1879); in the Bulletin of the Brooklyn Entomological Society (1879 and 1881); in the *American Entomologist* (1880); and in the Bulletin of the Illinois State Laboratory of Natural History (1880). The last of these articles, upon the Food of Predaceous Beetles, especially showed the traits for which he afterwards became well and widely known—in its evidence of close, acute, and thoughtful observation and of wide and attentive reading, and in the flavor of individuality which made his speech and writing interesting, on whatever topic.

It was by his engagement, in October, 1881, as an assistant in the Illinois State Laboratory of Natural History, then located at Normal, that the way he was seeking was opened to him when he was thirty-two years of age; and he came there, with his wife and two children, the following February, bringing with him his personal collection of

about twenty-five hundred named species of insects. The spirit in which he thus entered upon his long career of public service is shown in his letter of acceptance, in which he says: "I am not aiming to make money by just so much work for so much pay. I shall throw into the work all the zeal and thoughtfulness at my command; and as to the Laboratory, I feel like a partner in that already."

With the practical union of the Illinois State Entomologist's Office and the State Laboratory of Natural History in July, 1882, Webster became virtually an assistant to the State Entomologist; and the first published product of his work in this new relation was an article on the Angoumois grain-moth and its parasites, printed in the Twelfth Report of the Entomologist's Office.

In the summer of 1884 he was appointed to the United States service as field agent of the Division of Entomology under Riley, and was assigned for investigation the subject of the wheat insects, on which he had already made a substantial beginning. Studying first in Illinois, he was presently sent to Oxford, Ind., and thence to La Fayette in the fall of 1884. Here he made his headquarters for seven years as a special agent of the United States Department and nominal entomologist of the Indiana Agricultural Experiment Station, with which he worked in coöperation. He reported during this period mainly on the insects of the cereal crops, but he spent the early parts of several years between 1886 and 1891 in the south, chiefly in Louisiana and Arkansas, investigating the prevalent species of *Simulium* known as buffalo-gnats and black flies. From December, 1888, to April, 1889, he was on a voyage to Australia (extended to include Tasmania and New Zealand also), whither he was sent to report on the agricultural features of the Melbourne Exposition. For a year from July 1, 1891, he was stationed at Columbus, O., coöperating with the Experiment Station there, as he had done in Indiana; and when a reduction of appropriations compelled the discontinuance of his national work he remained with the Ohio station as its entomologist, accompanying it on its transfer to Wooster. It was during his residence in Ohio that he received from Ohio University (Athens) the honorary degree of master of science. Executive relations finally becoming difficult, he withdrew from the Ohio service in 1902, and returned to Illinois to resume his old relationship on the staff of the State Laboratory of Natural History, which had been transferred in the meantime to the University of Illinois at Urbana. Finally, in July, 1904, he entered on the last phase of his career as a special field agent again of the United States Bureau of Entomology, and, with the division of the Bureau into definite sections in 1906, he was advanced to the position which he occupied at the time of his death. Here as his

F. M. Webster

force was enlarged and his appropriations were gradually increased, he organized and directed one of the largest and most efficient of the divisions of the national entomological service; and this is only another way of saying that he had under his control one of the most important agencies of entomological investigation in the world.

During the thirty-four years of his service, besides inspiring, training, and assisting many young men, he contributed more than three hundred papers to the literature of his subject; and it is not too much to say that our accurate knowledge of the entomology of the forage and cereal crops, especially of the small grains, is in very large measure the product of his personal work. He was not by any means a narrow specialist, but was even more interested in the larger aspects and the remoter bearings of his problems than in their special details. The subject of the distribution, migration, and diffusion of insects especially engaged his attention; and he encouraged his assistants to work out not only the detailed life-histories of the forms they studied, but their anatomy and even their embryology also. He was nevertheless a thoroughly practical entomologist, held in close contact with the soil and the crop by the fact that he had been himself a farmer, and was financially interested in farming all his life.

As an executive he was a good judge of men and a careful, thoroughgoing, and persistent manager; and he gradually brought together in his large division a corps of capable young workers to whose training for their special tasks he gave close and helpful attention. In his relations to them he was critical but kindly, a wise and friendly adviser who attached his subordinates to him by bonds of loyalty and personal affection. "He was almost a father to all of us," one of them has lately said, "and was always looking out for our interests." Although something of a "fighter" in the better sense of the word, he was never a bitter partisan, and he was especially notable for his unswerving loyalty to those who had in any way helped or befriended him.

The high esteem in which he was held by his scientific associates is shown by the fact that, although an economic entomologist especially, he was chosen president of the Entomological Society of America at its Columbus meeting only a few days before his death.

He is survived by his wife, Maria A. [Potter] Webster (to whom he was married at Sandwich, Ill., in August, 1870), and by their two daughters and three sons.

STEPHEN A. FORBES.

SVEN LAMPA[1]

Born 1839; Died December 2, 1914

Sven Lampa was the first official representative in Sweden of economic entomology; he was one of the founders of the Swedish Entomological Society in 1879, which as one of its principal objects had the development of economic entomology in Sweden; he was during the years 1891–1901 the editor of the well known periodical of this Society *Entomologisk Tidsskrift* and was in 1908 elected honorary member of the Society. From 1879 to 1897 Sven Lampa had a scientific position at the entomological division of the State Museum in Stockholm; he made, however, during that period also several trips to different parts of Sweden to study in the field attacks of economically important insects. When the government in 1897 founded an institution for economic entomology, Sven Lampa was chosen as its chief without any competition and he held this position for twelve years till he, 70 years old, retired, 1907. His considerable knowledge, his common sense, his kindness and modesty gave him a great personal popularity, which contributed very materially to create general interest for economic entomology in Sweden. In *Entomologisk Tidsskrift*, 1915, has been published his biography by Chr. Aurivillius, his portrait and a list of his 210 publications.

A. Böving.

Reviews

The Embryology of the Honey-Bee, by James Allen Nelson, Ph. D., Expert, Bee Culture Investigations, Bureau of Entomology. Published by the Princeton University Press, 1915, pp. 1–282, with 95 text fig. 2, and 6 pls.

No domesticated animal has received more detailed and more loving study than has the honey-bee. Apiculturists as a group are broadly interested in the habits and behavior, the structures and the physiology of their charges, a fact well illustrated by the popular texts and the periodicals devoted to the subject. In spite of the wealth of data which have been accumulated, much fundamental work remains to be done, and American science is to be congratulated that this is being undertaken so thoroughly by the Division of Apiculture of the Bureau of Entomology.

One field which has been practically unopened to the student and even to the more technical worker, is that of the embryological development of the honey-bee. Aside from a handful of scattered papers in foreign and inaccessible literature, practically nothing has been known of the subject, in spite of the fact that it is not only of interest in itself but that it may throw important light upon other problems connected with bees and beekeeping. Indeed, aside from Wheeler's magnificent mono-

[1] Extract from Chr. Aurivillius: Sven Lampa, Entom. Tidsk. Vol. 36, 1915, p. 268-281. (Böving.)

graphs of some twenty-five years ago, based primarily on a study of the Orthoptera, and the translation of Korschelt and Heider, long since out of date in important features, the American student has had available practically nothing dealing broadly with insect embryology. This lack is met in a most admirable manner by the work before us.

Dr. Nelson has given us far more than a restricted study of the embryology of the honey-bee. In clear and lucid language, illustrated by numerous and carefully selected figures, he has presented a comparative discussion which may well serve as an introduction to the study of the general subject of insect embryology. Its value in this respect is very greatly increased by a detailed discussion of the methods employed, technique which is adaptable to the study of other forms. An excellent bibliography is also included.

This is not the place to discuss the more technical aspects of the book. Many new details are brought out, and many debatable questions are handled in an impartial and scholarly manner. It is a little disappointing not to find others—notably the question of the origin of the sex glands—more definitely settled, but one should not expect too much.

On the whole the author deserves hearty congratulations and the gratitude of all who may have to deal with the subject of insect embryology. It is a shame that a narrow publication policy has compelled Dr. Nelson to place his work in the hands of private publishers and has deprived the Bureau of Entomology of putting out directly a monograph which would have been a standing credit to it (*Advertisement*).

W. A. R.

Beekeeping, A Discussion of the Life of the Honeybee and of the Production of Honey. By E. F. PHILLIPS, PH. D., Bureau of Entomology, Washington, D. C., pp. i–xxii, 1–457, 190 figures, 1915. Rural Science Series, The Macmillan Company, New York. $2.00 net.

In preparing a book of limited size on a subject of which the author has a broad understanding, he is under the necessity of selecting not only his material, but his method of presenting it. In either case the class of readers addressed must be considered.

Although Phillips has addressed his book on "Beekeeping" to "American beekeepers," a perusal of its pages shows that the term is here applied, not only to all persons interested in bees, but more particularly to those who have had special training in entomology.

With the present rapid development of interest in beekeeping instruction and investigation in American colleges, the appearance of this book is most timely.

Since bees are not domesticated and can scarcely be said to be kept in captivity, their successful management is based entirely on a knowledge of their behavior under the varying conditions of season and locality. The application of this knowledge to practical management requires a correct interpretation and continuous control of colony conditions in relation to the season and locality in question.

In his preface the author states that "it has seemed desirable in the early chapters to discuss bees as they exist without man's interference, thus giving the foundation on which the practice of beekeeping rests. The beekeeper is not especially interested in the anatomy of the bee, and, while it is necessary to use illustrations of various organs and describe them briefly, an effort has been made to treat the bee as a living animal and to have the discussion deal with physiology and especially with activities, in so far as investigations have thrown light on these processes. In the preparation

of the chapters devoted to the management of the apiary, an effort has been made to present the various systems of manipulations in such a way that the underlying principles shall be evident, rather than to attempt to describe each system as if it were separate."

According to the author's plan, the book is divided into two main discussions: first, of bees as they exist without man's interference, and second, of how man may profitably use or interfere with natural colony conditions.

The first division occupies chapters 3 to 9, using 171 pages. According to an old phrase in teaching, the author here goes "from the known to the unknown." First taking the colony as the unit, he describes its morphology and physiology in the third and fourth chapters under the headings "Colony and Its Organization," and "The Cycle of the Year." Next, the subdivisions of the colony—the individual bees—are discussed, first in relation to the colony (chapter 5), then as to their own life processes (chapters 6, 7, and 8). Finally, chapter 9 gives the entomological classification of the bee, and the chief characteristics of the different races of honey bees.

Transition is made to the second main division by a discussion of regional differences in the United States with reference to beekeeping in chapter 10. The next two chapters give advice on first steps in beekeeping and apiary management. Then five chapters of only 86 pages give all the directions one finds in the book on bee management, with the exception of a short chapter later on devoted to queen rearing, and one on "The Care of Bees in Winter," which consists mostly of directions for letting them alone. True to his foreword, the author has presented these simple systems of manipulation, so that the underlying principles are evident.

So much then for the main divisions of the book. In addition to these, the first chapter, by way of introduction, discusses beekeeping as an occupation, and the second, one of the shortest, gives a list of the bare essentials of equipment, on the grounds, no doubt, that an art consists not of tools, but of their use. The remaining chapters deal with marketing the honey crop, the production and care of beeswax, the sources of nectar and pollen, bee diseases and enemies, and miscellaneous information. Every one of these chapters is worthy of special mention, but space is limited.

One's first impression of the book is that it is different. No other author has undertaken the subject in just this way. Placing principles first and emphasizing them all the time is fundamentally sound teaching. If there were any adverse criticism it would be that phases of the subject are not followed through from principles to management in the same chapter. For example, the wintering of bees is treated in chapter 4, and the care of bees in winter in chapter 20; but from different standpoints. According to the plan of the book, this is unavoidable.

In clearing away the fog of details of equipment and management, and presenting beekeeping as a scientific art using very simple tools and methods, the author has made a valuable contribution to bee literature.

The style is clear and concise, at times perhaps too condensed for the average beekeeper reader. The illustrations, mostly original, are pen drawings and are splendid. There are 457 pages with 24 chapters, 190 illustrations, and a very complete index. To say that "Beekeeping" is published in Bailey's Rural Science Series by the Macmillan Company, is sufficient commendation of binding, type, and general style of this most excellent publication (*Advertisement*).

M. P.

Scientific Notes

Poison Bran Mash Effective in Destroying Sow Bugs. In one of the sections of the Experiment Station greenhouse where the Department of Botany was carrying on plant breeding experiments, the alfalfa and clover plants were seriously injured by sow bugs. Some of the plants were almost completely destroyed. Sliced potatoes poisoned with Paris green were first tried but did not prove effective. The poisoned bran mash flavored with oranges prepared in the same manner as has been recommended on several occasions by the Kansas Station in the control of grasshoppers, army worms, and cutworms was then tried, and one application, which simply consisted in scattering a small amount of the mash in the evening about the base of the plants, killed practically all of the sow bugs.

GEO. A. DEAN, *Entomologist,*
Kansas Experiment Station.

Apicultural Courses. In reply to a questionnaire sent to colleges and universities, the following list of colleges teaching Apiculture has been prepared by Morley Pettit: College of Agriculture, Aberdeen, Scotland, John Anderson; Schools of Agriculture, Province of New Brunswick, Canada, H. B. Durost, Woodstock, N. B.; Ontario Agricultural College, Guelph, Morley Pettit; Massachusetts, Dr. B. N. Gates, Amherst, Mass.; New York, Cornell University, E. R. King, Ithaca, N. Y.; South Carolina, A. F. Conradi, Clemson College, S. C.; Tennessee, G. M. Bentley, Knoxville, Tenn.; Mississippi, R. W. Harned, Agricultural College, Miss.; Texas, F. B. Paddock, College Station, Texas; Ohio, Jas. Hine, Columbus, Ohio; Kentucky, H. Garman, Lexington, Ky.; Indiana, James Troop, Lafayette, Ind., and Walter Price; Michigan, F. E. Millen, East Lansing, Mich.; Wisconsin, H. F. Wilson, Madison, Wis.; Minnesota, Francis Jager, St. Anthony Park, Minn., and L. V. France, St. Paul, Minn.; Iowa, Prof. C. E. Bartholomew, Ames, Iowa; Missouri, L. Haseman, Columbia, Mo., and A. H. Hollinger, Columbia, Mo.; Kansas Agricultural College, Geo. A. Dean, Manhattan, Kan.; Kansas University, S. J. Hunter, Lawrence, Kan.; Nebraska, Lawrence Bruner, Lincoln, Neb.; Montana, R. A. Cooley, Bozeman, Mont.; California, Geo. A. Coleman, Berkeley, Cal. If there are any errors or omissions, the writer would like to be advised.

A Democratic Plan. On Nov. 1, 1915, the reorganization of the Division of Entomology of the Minnesota Agricultural College and Experiment Station took effect. The new organization is as follows:

The name of the division is changed to that of Economic Zoölogy. It is divided into four sections: A, Economic Vertebrate Zoölogy, Professor F. L. Washburn in charge, who also conducts Nursery Inspection work and has charge of all work with mill and ware-house insects and with Minnesota Hymenoptera. Mr. Washburn retains his title of Professor of Entomology in the University of Minnesota. B, Spraying and Tree Insects, Associate Professor A. G. Ruggles in charge. C, Field Crop Pests and Parasites, Assistant Professor C. W. Howard in charge. D, Greenhouse and Truck Crop Insects, Assistant Professor William Moore in charge.

The administration of the division lies in the hands of a committee composed of the heads of sections. The Chairman of the committee (an executive position) is appointed annually by the Dean of the College, with the approval of the President of the University and of the Board of Regents. Professor F. L. Washburn was appointed Chairman for the present year. The position of Chairman carries with it that of Entomologist to the Experiment Station and a State law provides that the Station Entomologist shall be State Entomologist.

This organization is rather a remarkable step in the direction of a greater democracy in the management of a University Department and may interest other entomologists.

F. L. WASHBURN.

Current Notes

Conducted by the Associate Editor

Mr. G. G. Schweiss, assistant in entomology at Nevada University, resigned August 1, 1915.

Mr. L. V. France has been appointed instructor in beekeeping at the University of Minnesota.

Dr. W. S. Regan is instructor in entomology in the Massachusetts Agricultural College, Amherst, Mass.

Dr. M. C. Tanquary has been appointed instructor and assistant in entomology at the Kansas College and Station.

Mr. E. B. Blakeslee, Bureau of Entomology, has returned to Washington from his field station, Winchester, Va.

Mr. B. R. Leach, Bureau of Entomology, returned to Washington from his headquarters at Winchester, Va.

Mr. D. L. Van Dine, Bureau of Entomology, visited Washington near the end of November and remained several weeks.

Mr. F. L. McDonough, Bureau of Entomology, completed the determination of the boll weevil dispersion in Florida during November.

Mr. L. M. Gates, field expert in entomology at the University of Nebraska, has resigned to engage in farming.

Mr. A. H. Jennings, Bureau of Entomology, was absent on furlough for the month of December on account of ill health.

Mr. B. P. Young, a graduate student, has been appointed instructor in entomology at the University of Kansas. His work will be along morphological lines.

Mr. P. W. Claassen, Assistant State Entomologist at the University of Kansas during the past two years, is now Research Assistant at Cornell University.

Dr. Henry Fox, Bureau of Entomology, who was stationed temporarily during the summer at Tappahannock, Va., has returned to his field station at Charlottesville, Va.

Mr. C. C. Hamilton, Bureau of Entomology, temporarily engaged at Rocky Ford, Colo., has reëntered the University of Illinois, Urbana, Ill.

Mr. C. P. Clausen has been appointed assistant superintendent of the State Insectary at Sacramento, Cal., vice H. L. Viereck, resigned, and has entered upon his duties.

Dr. T. J. Headlee, New Brunswick, N. J., has been appointed entomologist of the Society of American Florists and Ornamental Horticulturists for the coming year by President MacRorie.

Mr. V. L. Wildermuth, Bureau of Entomology, who visited Washington in the fall while engaged in the preparation of manuscript, has returned to his field station at Tempe, Ariz.

The cranberry insect laboratory of the Bureau of Entomology, formerly at Pemberton, N. J., in charge of Mr. H. B. Scammell, has been transferred to Brown's Mills, N. J.

J. D. Smith and J. U. Gilmore, Bureau of Entomology, who arrived in Washington on November 4, were compelled to return to their homes on November 27 on account of illness.

Mr. R. N. Wilson, Bureau of Entomology, who spent a part of November in the office at Washington preparing manuscript, has returned to his field station at Gainesville, Fla.

At the Annual Meeting, December 10, Mr. George H. Hollister was elected president of the Connecticut Horticultural Society at Hartford. Mr. Hollister is now superintendent of Keney Park in Hartford.

Mr. J. Turner Brakeley, a student of mosquitoes, co-worker and friend of the late Dr. John B. Smith, died recently at his home, Lahaway Plantations, N. J., aged sixty-eight years.

Mr. Irving R. Crawford, Bureau of Entomology, temporarily attached to the range caterpillar investigations at Maxwell, N. M., has resigned from the service in order to engage in other work.

Mr. R. A. Cushman, Bureau of Entomology, of the North East, Pa., laboratory, has returned to Washington and will be engaged during the winter in monographic work on parasitic Hymenoptera.

Mr. A. I. Fabis, Bureau of Entomology, connected with the laboratory at Monticello, Fla., engaged in pecan insect investigations, has returned to Washington for the purpose of conference and library work.

According to *Experiment Station Record*, Mr. D. T. Fullaway resigned June 30, 1915, as entomologist of the Hawaii station to become field entomologist of the territorial board of agriculture and forestry.

The connections of temporary appointees in the Bureau of Entomology, Messrs. C. H. Alden, W. B. Cartwright, and H. L. Dozier, have been severed on account of expiration of the periods for which they were employed.

In the work on the potato-tuber moth, which has been carried on for some time by the Bureau of Entomology, thirteen parasites and one hyperparasite have been studied by Mr. John E. Graf.

Mr. Dwight Iseley, Bureau of Entomology, has returned to Washington from the North East, Pa., laboratory, where special attention was given during the summer to field experiments in the control of the grape-berry moth.

Mr. H. H. Kimball, Bureau of Entomology, returned to Agricultural College, Miss., from New Orleans on the 15th of November. He will make a local malaria mosquito survey of the vicinity of the College during the winter.

Mr. E. H. Siegler, Bureau of Entomology, who is engaged in investigations of the codling moth in Grand Junction, Colo., has arrived in Washington and will be engaged during the winter in the preparation of notes, manuscripts, etc.

Mr. Samuel D. Gray has been appointed professor of entomology at the Porto Rico College, vice R. I. Smith, whose resignation to take up quarantine work for the Federal Horticultural Board was announced a few months ago.

According to *Science*, a biological expedition to the island of Santo Domingo will be made next fall by Professor J. G. Needham, and Messrs. J. T. Needham, Ludlow Griscom and K. P. Schmidt of the entomological department of Cornell University.

The Annual Massachusetts convention of beekeepers will be held at Amherst, Mass., March 14 to 16, inclusive. This convention will conclude the winter school of beekeeping at the Agricultural College.

Professor Geo. A. Dean, of the Kansas State Agricultural College, Manhattan, Kan., will offer the courses of instruction in entomology in the second term of the Summer Session, at the University of Kansas, Lawrence, Kan.

Mr. Geo. H. Vansell resigned his position on the staff of the State Entomologist of the University of Kansas, on December 1, to accept the position of assistant professor of entomology at the University of Kentucky.

Mr. Fred W. Poos, Jr., a graduate student of the University of Kansas, takes the place on the staff of the State Entomologist made vacant by the resignation of Mr. Vansell.

According to *Science*, Assistant Professor A. L. Lovett has been made acting head of the entomological department of the Oregon Agricultural College, vice H. F. Wilson, who resigned recently to accept a professorship in entomology at the University of Wisconsin.

Entomological News announces the death of Dr. Frederick W. Russell, formerly of Winchendon, Mass., on November 20, 1915, at the age of 71. Dr. Russell was particularly interested in the Lepidoptera and for years collected moths at light at his home in Winchendon.

According to *Science*, Mr. Herbert T. Osborn, a graduate of Ohio State University in 1909, and son of Professor Herbert Osborn, has been sent by the Sugar Planters' Association of Honolulu to Formosa to secure parasites to use in Hawaii to control the cane beetle.

Mr. E. W. Geyer, Bureau of Entomology, who spent the summer at Roswell, N. M., in orchard spraying and dusting work, has returned to Washington for conference and for the completion of the report on the life history of the codling moth in New Mexico.

Mr. E. R. Van Leeuwen, who has been assisting Mr. Siegler in codling moth investigations at Grand Junction, Colo., has been transferred to the Bureau of Entomology field station at Benton Harbor, Mich. Mr. Van Leeuwen will shortly leave the service to resume his college studies.

Mr. Henry L. Viereck, who recently resigned from the California State Insectary, for a few weeks in November was at the American Museum of Natural History, New York City; he is now connected with the Bureau of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

According to *Entomological News*, M. Charles Kerremans, a student of the Buprestidæ in Europe, died October 10 at the age of 68. Mr. Kerremans was engaged in the preparation of a monograph of this family of beetles, which had not been completed at the time of his death.

Entomological News records the death, on November 16, 1915, of Professor Raphael Meldola of London, England, aged 66. Professor Meldola was the author of many entomological papers and a member of several scientific societies. In 1895 and 1896 he was president of the Entomological Society of London.

According to *Science*, King Ferdinand of Bulgaria has been removed from membership in the Entomological Society of France, which he has held since 1882, and in the Petrograd Entomological Society. The latter has elected in his place M. Lameere of Brussels, who is now working in the Paris Museum of Natural History.

Mr. Curtis P. Clausen, Assistant Superintendent of the State Insectary at Sacramento, Cal., sailed for the Orient on January 8, for the purpose of collecting parasites and predators for use against scale insects injurious in California. His field will be Japan and Formosa, and possibly China later.

Mr. J. W. Bailey, Bureau of Entomology, who has had experience with Mr. M. M. High in onion insect investigations at Brownsville, Tex., and who has been a collaborator during the year at Starkville, Miss., entered Cornell University at the beginning of the college year, to complete his course in entomology.

The Michigan Agricultural College announces a short course or "beekeepers' week." March 13 to 18. Both men and women are welcome. There are no fees and no age limits. Mr. F. Eric Millen is instructor in beekeeping and also State Inspector of Apiaries.

Mr. George B. Merrill, recently connected with the Gipsy Moth Laboratory at Melrose Highlands, Mass., has accepted the position of Deputy Port and Railway Inspector with the State Plant Board of Florida. Mr. Merrill will be stationed at Tampa.

Mr. A. C. Mason, until recently connected with the Nursery Inspection work in Florida, has been appointed as Assistant to Dr. E. W. Berger, entomologist of the Florida Plant Board, and will be located at the Plant Board laboratory at Gainesville.

G. E. Bensel, collaborator, Bureau of Entomology, has been appointed Supervising Agriculturist of all of the Southern California Sugar Companies for the purpose of improving the present cultural method of the sugar beet crop, and to supervise the combating of various enemies affecting this crop, especially nematodes. His headquarters are Los Angeles, Cal.

Mr. Donald J. Caffrey of the Bureau of Entomology, stationed at Maxwell, N. M., visited Washington in December and January and spent his vacation at his home in Massachusetts. On his return he visited the entomological department of the Agricultural Experiment Station at New Haven, Conn., where he was formerly an assistant.

Professor Gordon M. Bentley, formerly State Entomologist and Pathologist of Tennessee, has been reinstated. It was announced in the last number of this JOURNAL that Governor Rye had refused to reappoint Professor Bentley. It seems that instead he appointed a nurseryman, Mr. Bing of Smithville, and the office was removed to Smithville. Mr. Bing has now resigned and Professor Bentley has been reappointed to his former position.

Professor James G. Needham of Cornell University visited the University of Kansas, Lawrence, Kan., in November, and delivered an address before the entomological club on "The Ecology of Certain Aquatic Larvæ," and also spoke before all students of biology on "The Common Ground of Poet and Naturalist." A smoker was given in the evening in honor of Professor Needham and to enable the University men to meet him.

According to the *Experiment Station Record*, contracts have been awarded for the new biology building at the University of Nebraska, which will house the departments of botany and zoölogy and will bear the name of Bessey Hall. The structure will consist of a three-story and basement main building, 235 x 75 feet, with a short wing at each end and attached greenhouses and vivaria, and will cost approximately $200,000.

Mr. George H. Corbett of Trowbridge, Wiltshire, England, who was in the United States last year as a Carnegie student, has offered his services to his country for entomological and hospital work at the front. While in this country Mr. Corbett visited many official entomologists and experiment stations in the United States and Canada and he wishes to express publicly in the JOURNAL OF ECONOMIC ENTOMOLOGY his gratitude to all entomologists who gave him so much valuable assistance while here.

The Florida Entomological Society has recently been organized at Gainesville, Fla., with fifteen charter members. The first officers elected were: Prof. J. R. Watson, Entomologist of the Florida Experiment Station, president; Mr. Wilmon Newell, Plant Commissioner of the Florida Plant Board, vice-president; and Mr. R. N. Wilson, U. S. Bureau of Entomology, secretary-treasurer. A paper was read on the Velvet Bean Caterpillar (*Anticarsia gemmatilis*), by Professor Watson, and another on the Fungous Diseases of Scales and White Flies on Citrus, by Dr. E. W. Berger, Entomologist of the Florida Plant Board.

In the District of Columbia, Dr. F. H. Chittenden of the Bureau of Entomology has found that the abutilon moth (*Cosmophila erosa*) has not appeared on abutilons at all; a few have been found on hollyhocks; and four individuals were taken from morning-glory. Two of these looked perfectly healthy when received, were full-grown, and had the characteristic markings on the back. All four died owing to the attack of the minute egg-parasite (*Litomastix* (*Copidosoma*) *truncatellum*. This latter species has been very abundant during the year and has perhaps been more instrumental in keeping down the numbers of the cabbage looper (*Autographa brassicæ* Riley) than any other single cause.

Mr. D. J. Caffrey, Bureau of Entomology, reports the recovery of the parasitic fly, *Compsilura concinnata*, from specimens of the range caterpillar taken at a point where a colony of the fly was liberated during the summer of 1914. This apparently indicates that the parasite has become established. Mr. Caffrey also reports the range caterpillar as injuring seriously corn and other cultivated crops in the vicinity of Maxwell, N. M., during the past summer. The insect has heretofore confined its attentions almost exclusively to the blue gramma grass of the cattle ranges.

In coöperation with the Office of Home Economics of the States Relations Service, a series of experiments are being conducted by the Bureau of Entomology with a colony of bees placed in a respiration calorimeter. The object of these experiments is to determine the exact quantity of heat given off by the bee colony under different

conditions in regard to the temperature, humidity, and the carbon dioxid and oxygen content of the surrounding air. The water vapor and the carbon dioxid given off by the bees under these different conditions are also determined. Mr. W. A. Parks of Washington, D. C., has been appointed as student assistant and assigned to this work.

Mr. Neale F. Howard, Bureau of Entomology, who has been working on root maggots and other insects at Green Bay, Wis., has entered Ohio University, Columbus, Ohio, for a postgraduate course, under the direction of Professor Herbert Osborn. Mr. Howard reports that tarred felt pads, first invented by Goff, have been used by some of the gardeners in the vicinity of Green Bay since the early 90's and with perfect success. When made of the right material and properly placed the percentage of efficiency is practically 100. It is not applicable to cabbage in seed beds, but if it could be adapted to the control of the onion maggot, a near relative, it would be an ideal method.

Science states that the equipment of the department of entomology at the University of Illinois, and of the natural history survey of that state, receives a notable addition in the new vivarium building in Champaign, which will contain a large insectary for student use, with three laboratory rooms in connection, an apparatus, furnished conjointly by the university and the State Laboratory of Natural History, for temperature and humidity control in the study of insect life-histories, and a set of experimental aquaria fitted up for exact studies on the ecology of fresh-water animals. The insectary and entomological laboratories will be under the charge of Dr. R. D. Glasgow, and the state laboratory equipment under that of Dr. V. E. Shelford, of the laboratory staff.

The following note was printed in *Science:* "At the two hundred and ninety-first regular meeting of the Entomological Society of Washington the constitution was amended so as to permit the election of an honorary president, such office to be tendered only to active members who have been especially prominent in the affairs of the society and to convey with it expressions of gratitude, respect and honor. After creating this office, the society elected unanimously Mr. E. A. Schwarz as first honorary president. Mr. Schwarz was one of the charter members of the society, has held the office of president for two terms, vice-president for a number of terms, and secretary for a number of terms and has taken an active interest in the affairs of the society. He has attended every meeting of the society when he has been in Washington, has contributed greatly to its financial support and has entertained the society more than any other member. He is an internationally recognized authority on Coleoptera and has contributed materially to the advancement of his favorite group and also to the general science of entomology."

The following note occurs in the November *News Letter* of the Bureau of Entomology: In a memorandum to this office dated November 6, 1915, Dr. W. D. Hunter, in charge Southern Field Crop Insect Investigations, stated: "The recent hurricane injured practically every building in New Orleans, La., more or less, and hundreds were completely demolished. . . . Many of the exposed beams were mined by insects and in many cases at least this weakening of the timbers was an important contributory cause of the loss." The insects usually responsible for this type of injury are termites and "powder post" beetles. Damage to timbers of buildings by termites is occasionally serious even in the northern states. "Powder post" beetles also often seriously injure the beams of buildings. But this is the first instance of the interrelation of storms and insects in the destruction of buildings

that has come to our notice, although similar interrelation between insects and storms in the destruction of telephone and telegraph poles has been commonly noted. We will be glad to receive specimens of the insects or insect-damaged wood from buildings in the region of the storm above referred to.

Mr. S. A. Rohwer of the Bureau of Entomology has just completed a summary of the first year's growth of the nursery connected with the Eastern Field Station. This nursery now consists of twenty-three species of deciduous trees which are represented by one hundred and thirty specimens. There were one hundred and thirty-nine planted, which makes a loss of nine. Of these one hundred and thirty trees, eleven are at present used in experiments to determine the life-history of insects injurious to forest trees. Some very useful experiments are being carried on with trees of *Robinia pseudacacia* to determine the life-history of *Ectydolopha insiticiana*. These experiments are under the direction of Mr. Heinrich. The coniferous nursery is composed of three species of *Abies*, two species of *Larix*, three species of *Picea*, fifteen species of *Pinus* and one species of *Pseudotsuga*, a total of twenty-four species. There were twenty-one hundred and ninety-nine coniferous trees planted. Of these, fourteen hundred and sixty-six are living, which means a loss of 33⅓ per cent. Thirty of the coniferous trees are now used in experiments. Most of these experiments are for various species of *Evetria* and *Diprion*. Some of the coniferous trees which have done especially well are *Pinus ponderosa, resinosa, sylvestris* and *divaricata*. The two species of *Larix* show marked difference in their adaptibility to eastern conditions. In the plot of *Larix occidentalis* there are only ten trees living, ninety-two having been killed by the summer. In the plot of *Larix leptolepsis* (Japanese larch) there are sixty-five living trees and some of these have made phenomenal growth.

At a meeting in New York City, November 17, there was formed the Interstate Anti-Mosquito Committee, consisting of two members each from New York City, Nassau and Westchester counties, and the adjoining states of Connecticut and New Jersey. This committee held a meeting at the offices of the Department of Health, New York City, January 12, 1916, and mapped out a program for work. Its membership is as follows:

New York City: Dr. Haven Emerson, Health Commissioner, Mr. Samuel Eckman, Forest Hills, N. Y.

Westchester County: Dr. A. Hoyt, New Rochelle, N. Y., Mr. Collin Armstrong, Scarsdale, N. Y.

Nassau County: Dr. Frank Overton, Patchogue, L. I., Mr. W. J. Matheson, Huntington, L. I.

New Jersey: Dr. Thomas J. Headlee, State Entomologist, New Brunswick, N. J., Dr. Ralph H. Hunt, East Orange, N. J.

Connecticut: Dr. W. E. Britton, State Entomologist, New Haven, Conn., Dr. Valery Havard, U. S. A. (Retired), Fairfield, Conn.

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(*Papers held for publication later or read by title.*)

LACHNOSTERNA RECORDS IN WISCONSIN

By J. G. SANDERS and S. B. FRACKER, *State Capitol, Madison, Wis.*

By means of a special fund granted by the Wisconsin legislature of 1913, experiments were carried out in 1914 and 1915 with regard to the serious white grub pests of the genus *Lachnosterna*, which have caused heavy losses during recent years. Several factors to be considered included: the determination of conditions; crops most seriously damaged with and without rotation; the species present and their habits, life-history, distribution and means of control.

It was decided that lantern traps be used as a means of collecting large numbers of the beetles for the purpose of determining the species to be found in the lower portion of the state, their attractiveness to lights with regard to sex, and the possibility of economic control in this manner. Some interesting information as to the number of species concerned and their relative abundance and distribution was secured. Some of the results are briefly outlined here.

The forty trap-lights used consisted of the Coleman gasoline arc lantern (Fig. 10), furnishing 300 to 400 candle power, set into large, galvanized refrigerator pans, five inches deep and about twenty-four inches in diameter. These pans were filled about two-thirds full of water, and one-half pint of kerosene was poured on the water and renewed when necessary. Perforated skimmers were used to remove the captured insects.

The five stations (Fig. 11) in the southern third of the state were located as follows: at Lancaster in the southwestern corner of the state, fifteen miles from the Mississippi river and twenty-five miles from the Illinois state line; at Dodgeville, thirty miles east and slightly north of Lancaster; at Madison, thirty-five miles east and north of Dodgeville; at Baraboo, forty miles northeast of Dodgeville and thirty-five miles northwest of Madison; and at Ripon, fifty miles northeast of Baraboo. With the exception of Madison, the stations were situated in a line running northeast from Lancaster, 120 miles to Ripon.

Fig. 10. Coleman Gasoline Arc Lantern (300–400 candle power) used in trapping experiments. [Cut furnished by the Coleman Lamp Co., Wichita, Kans.]

Generally speaking, Lancaster and Dodgeville are located similarly in a high rolling plateau region. Madison is on a lower level of black soil to the east of a hilly region. Baraboo is in a distinct region north of the Wisconsin river valley, featured by bold granite hills and higher plateaus. Ripon is in a lower rolling region of black soil. The latter two stations record slightly lower temperatures.

The forty light traps were operated from the time of the first flights in early May until late in June, and succeeded in catching an approximate total of one million thirty-six thousand four hundred (1,036,400) beetles.

Some striking results were obtained with regard to the distribution of species in this comparatively limited area, the optimum temperatures for flights, favorable location and arrangement of light traps. A mere summary of important results seems most desirable in this paper.

Temperature an Important Flight Factor

With 7 p. m. temperatures much below 66° Fahrenheit, flights were very small and almost ceased at 62°. Results show that 99.6

per cent of the entire catch of over 110,000 beetles at Baraboo and 99.1 per cent of the 14,500 at Ripon were made at 66° and upward. With higher temperatures, however, the volume of the flight did not always increase to a maximum at the highest degrees. Other weather conditions, such as cloudiness or moonlight, appeared to have less effect than is usually attributed to them.

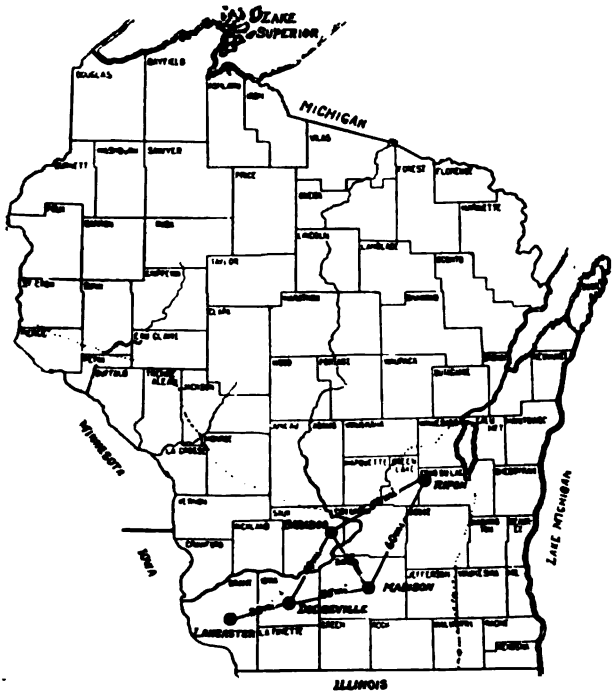

Fig. 11. Map of Wisconsin, showing trap-light stations and intervening distances. Dotted line bounds area of white grub damage.

The following table is a typical record from Baraboo:

Date	Weather Conditions	Temp. 8.00 p. m.	No. Beetles
May 14	Clear and calm	54°	0
May 15	Clear and calm	57°	0
May 16	Clear and calm	61°	135
May 17	Clear and calm	64°	154
May 18	Clear, light south wind	69°	1,250
May 19	Clear, light south wind	70°	1,902
May 20	Cloudy, light south wind	73°	3,156
May 21	Clear and calm	62°	155
May 26	Cloudy, warm south wind	80°	22,700

Distribution of Species

Species of Lachnosterna Captured at Trap Lights

A Comparative Table on a Basis of 10,000 Beetles

	Lan-caster	30 mi...Dodge-ville	..35 mi....40 mi....Madison	..35 mi...Bara-boo	50 mi...Ripon
No. beetles caught...	440,000	271,600	?	110,285	14,519
No. beetles identified	12,246	16,268	10,839	16,847	14,519
L. fusca............	9,669	9,328	3,903	934	1,290
L. rugosa...........	0	1	5,967	8,483	7,628
L. grandis..........	83	4	59	12	959
L. dubia............	20	6	7	547	111
L. hirticula..........	25	225	0	4	4
L. gibbosa..........	47	251	4	2	0
L. ilicis.............	33	173	19	10	0
L. balia.............	52	1	0	1	0
L. tristis............	29	0	0	0	2
L. nitida............	15	4	7	1	2
L. implicita.........	19	0	0	0	1
L. marginalis........	3	1	30	0	0
Other species........	5	6	4	6	3

(L. vehemens, nova, prunina, inversa, villifrons)

As will be seen by the accompanying table, there is a remarkable variation in distribution of species within a short distance of thirty or forty miles. Seventeen of the nineteen species known to occur in Wisconsin were taken in these traps. Mr. J. J. Davis adds *L. hornii* and *L. crenulata*[1], collected at Baraboo June 2, 1914, and a specimen of *L. crenulata* from Milwaukee County is also in the Milwaukee Museum. Not less than 10,839 specimens were determined for any station, ranging upward to 16,847—at Baraboo. The entire catch at Ripon has been determined specifically.[2]

In this comparative table computed on a basis of 10,000 beetles, it is seen that *L. fusca* is more cosmopolitan than any other species and is dominant at Lancaster and Dodgeville. *L. rugosa* did not appear at Lancaster, the southwest station, but is dominant at the three northeasterly stations.

L. implicita, which was found most abundant by Dr. S. A. Forbes in Illinois in 1906, is rare at Lancaster and did not appear elsewhere except a lone specimen out of 14,519 determined from Ripon.

Only males of *L. gibbosa* and *L. nitida* were attracted to our lantern traps, and *L. tristis* also is but slightly attracted.

[1] After this paper was sent to the editor three specimens of *L. crenulata* were found in the trap collections from Baraboo.

[2] Much praise is due Mr. Neale F. Howard, now assistant at the Ohio State University, Mr. Stewart Chandler and Mr. T. T. Haack for their great care and painstaking efforts in determining all but a few of these specimens. The rarer species have been passed upon by Mr. J. J. Davis.

It will be noticed that several species almost disappear at the stations farther northeast, although *L. rugosa, dubia*, and *grandis* gain in numbers. An interesting record is the capture of *L. dubia* at Dodgeville, only previous to May 21, although the traps were run for another month. At Baraboo we took 92 per cent of the catch (377) of this species before the same date, thus indicating unusually early emergence.

Large Trap Pans Desirable

By surrounding the central pan, below the gas lantern, with six similar pans, it was found that 76.4 per cent of the beetles attracted to the light at Ripon, missed the central pan and were caught in the adjacent pans. It was found, also, that a pan placed on the side of the central pan toward the origin of flight caught twice as many beetles as a pan placed behind the light. The desirability of using as large a pan as possible is evident. There appeared to be no relative difference of sexes in the several pans.

An ordinary barn lantern used for the trap was found to be practically worthless when used less than 100 yards distant from one of the gasoline lights, but when used alone at some considerable distance caught a fair amount of beetles approximating 30 to 35 per cent of the efficiency of the gasoline light.

At the Lancaster station the direction of flight was always from the northwest toward the southeast. This phenomenon can possibly be explained by the fact that the flight seemed to be directed up a valley at the head of which was a fair-sized grove of trees, principally oak, ash and walnut. Another small valley diverging from the first was treeless and there the catch was very light, whereas in the adjoining small valley with trees available the catch was many times larger. Traps near the margin of woods or close to a fringe of trees were in all cases most successful and doubly efficient.

Economic Results

Any attempt to draw close conclusions on the beneficial results of the capture of these large numbers of beetles in 1914 would be undesirable and the resulting judgment inaccurate, owing to the nature of the season the following year. The heavy and frequent rains of 1915, accompanied by exceptionally low temperatures, resulted in retarded and weak crops.

Mr. W. A. Johnson, who was in immediate charge of the lanterns at Lancaster, states he feels certain, after constant observation throughout the summer of 1915, that the destruction of more than 440,000 beetles on his farm has served as considerable protection for his

crops. He reports that his corn was not noticeably injured, although a few grubs were present in the soil, while many of his neighbors' corn-fields were severely damaged. The only loss which he noted was on a far side of the farm where potatoes were injured somewhat. Too much emphasis must not be laid on this fairly accurate observation, because the grubs were destroyed in considerable numbers by diseases, aided by the damp weather. Had this summer been a normal season, we feel that a fair estimate of value of the experiments could have been made.

At Lancaster, where fifteen light traps were running, it is estimated that under ordinary farm conditions where help is comparatively cheap, the total cost of operation of the lights, exclusive of the initial expense of lights and pans, would not exceed twenty-five or thirty cents a day for the entire period. It is further evident with the knowledge that we have of the small flights of beetles in temperatures under 66° F., the cost of operation could be materially reduced by omitting the lights on nights of low temperature.

The Proportion of Sexes

Altogether our records show that the numbers of males caught greatly exceed the females, it is possible that some other reason may be attributed to this fact rather than the smaller degree of attractiveness to lights in the females. It may be possible that normally there are larger numbers of males than females.

It may be argued that the catch of such a small proportion of females would militate against the success of light traps in economic control, but again, if the beetles are polyandrous, as has been suggested by some entomologists, there may be an unexpected advantage in catching such a large number of the males.

Our records further show that with the more common species the females form a larger percentage of the catch in the earlier part of the season.

On the whole, this question of possible control of the white grub pest by trapping of the adult beetles must receive much further attention and consideration before any definite recommendations can be made.

Biological Experiments

The following experiments were undertaken in order to learn as much of the normal life of white grubs as possible. No investigations seem to have been made heretofore on the activities of any underground animals in their natural environment. For this reason the only control measures which have been suggested in the past are

partially empirical and partially based on very meagre information. This report is preliminary and the more promising lines of work will be continued. Attempts will also be made, where possible, to apply the results in a practical way.

In these experiments we tried to find out whether white grubs had daily or seasonal habits, such as those of cutworms, what was their relation to temperature and to moisture, what foods they would eat, and what part of the plants they preferred. Efforts were also made to control them by stomach poisons, contact insecticides, and repellents. No work was done with fumigants as this phase of the subject has been carefully studied by previous workers.

Two forms of cages were used, most of the work being done with ordinary flower pots. In working with this type of cage, which Davis has found to be most satisfactory for rearing the grubs, it is necessary to empty the flower pot at each examination. In all cases where continuous observations seemed desirable, glass cages (Fig. 12) were used in which the earth was placed between two vertical glass plates less than one-half inch apart. Opaque shields were used to keep out the light except at the moment the grubs were examined. It was found possible to regulate the distance between the glass plates so that any size of grub could be seen from at least one side at any time and still leave sufficient freedom for the grubs to move actively back and forth. When young corn plants were placed in the soil between the plates, the roots were readily eaten and usually completely destroyed.

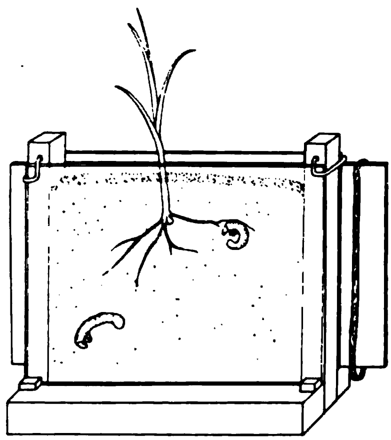

Fig. 12. Cage for Biological Studies of White Grubs.

The experiments may be divided into seven groups, all the important results so far secured being given below:

1. It was found that grubs have no daily migration, such as cutworms. They were never observed either eating or active late in the evening, early in the morning, or on cold days. Their movements reached the maximum during the heat of the day. There does not seem to be a vertical migration in relation to temperature changes, the larvæ in sod usually remaining close to the surface of the soil at all times but moving about and feeding only during warm weather.

The effective temperature of the soil seemed to be between 60° and 65° F., for when it was colder than this they did not move in the soil, did not feed, and scarcely made any resistance to handling.

2. Their food was found to consist, so far as observed, of the roots of plants only, or the fragments of these roots. They were never seen eating or manifesting any interest in any form of sweetened bran, dough or flour paste. In sprouting seed they uniformly ate the radicle and left the caulicle unharmed. This is also apparently true in the case of strawberries in the field, even when they have been planted so deeply as to cover the petioles of the leaves. In the case of grass it is more difficult to be certain of this habit.

3. Grubs were reared in flower pots containing moist garden soil with no apparent food from May 5 to July 18; the soil was then allowed to dry and on the 22d of October two larvæ were still found emaciated but alive and active in soil almost completely desiccated. The grubs then succeeded in living on minute root fragments and other humus in the soil for five and one-half months, of which the last three were passed in almost bone-dry surroundings. Under these circumstances, starvation methods of controlling them are proven impracticable.

4. Poison bran mash was found to be valueless against the grubs whether drilled into the earth above or below the larvæ or placed on its surface. This is, of course, due to the fact that they will not eat the bran.

5. In several experiments, including about forty grubs, grass roots were shaken free from earth, dipped in various arsenicals, and planted, in an attempt at poisoning the grubs. The use of sodium arsenite in this way, in the proportion of five pounds to fifty-four gallons of water, resulted in killing six larvæ out of a total of twenty-seven subject to poisoning, a mortality of 22.2 per cent in four days. No injury to the grass was observed. Attempts to accomplish the same results with lead arsenate in the proportion of five pounds of the paste to fifty gallons of water were unsuccessful. Corrosive sublimate used in the same way on a small corn plant caused a mortality of 50 per cent, but not in time to save the plant, as the roots were entirely eaten away by the grubs.

6. Kerosene emulsion and Black Leaf "40," in their ordinary strengths, did not affect the larvæ in the least when the soil was saturated with these solutions.

7. Professor H. T. Fernald a few years ago reported the successful use for two seasons of a repellant of tar on seed corn in preventing the attack of wireworms. Several repellants were tried in the experiments here being reported, but the only one which did not injure the

plant was creosote. Grubs apparently avoided the region where corn seed which had been dipped in creosote had been planted and did not attack the young corn which sprouted from it. These results, however, had not been anticipated and have not yet been followed up.

In connection with the insecticide experiments it should be stated that of the sixty-three larvæ which were reared in the flower pots, but on which no experiments were tried, ten died of bacterial or other diseases within forty days. This gives an average mortality in the check pots of 15.9 per cent for the six weeks.

In conclusion, it may be stated that the results in connection with temperature and the nature of the food supply seemed most significant. It is also of interest to note that white grubs are not immune from arsenical poisoning as wireworms have been said to be, and that there is a possibility that repellants will prove of some value in controlling them.

A PROGRESS REPORT ON WHITE GRUB INVESTIGATIONS[1]

By John J. Davis, *U. S. Bureau of Entomology, West Lafayette, Indiana*

The white grub (*Lachnosterna*) investigation was begun at the Lafayette Station of the federal Bureau of Entomology in 1911 and has been one of the major problems of this station continuously since that date. The report herewith presented is very brief and but an outline of some of the more important studies made by the writer or under his direction and is given at this time as a guide for those in the federal Bureau as well as station and state entomologists who are coöperating with us in this large problem and for others who are or may have occasion in the near future to take up this problem.

The plan and scope of our studies are comprehensive in the broadest sense, including not only life-histories and habits of the different species of *Lachnosterna* and means of control in this section of the United States but studies in the embryology, the distribution of species in all parts of the country in relation to soil, timber, farming methods and other environmental conditions, destructive broods of different species, systematics, etc., as well as thorough studies of the related genera, with especial reference to the economic importance and life-history of these related genera and means of distinguishing the larvæ of the different genera and of the different species in each genus. It is hoped eventually to have worked out the life-history and habits of every species of *Lachnosterna* and species of related genera for the various localities where each may occur.

[1] Published by permission of the Chief of the U. S. Bureau of Entomology.

The studies on the habits and life-histories have been conducted both in the field and in the laboratory. For instance, most of the studies to determine the habits of beetles, their food habits, etc., and the habits, etc., of the grubs have been made in the field with extensive observations and feeding experiments in confinement to corroborate our field observations. On the other hand, detailed studies of the various stages of the life cycle, the total life cycle, and the like, were conducted largely in breeding cages approximating as nearly as possible natural conditions. A discussion of the different cages used has already been given in this journal.[1]

Life-history Investigations

In this paper we will undertake to show only the more general conclusions and those which have a definite bearing on the economic phase of the subject. To date eighteen species of *Lachnosterna* have been reared from egg to adult and there are at least half as many more, the life cycles of which we are reasonably certain although it will be another year before we will have actually bred adults from eggs. The accompanying table will give data relative to the grosser points in the life cycle of the species studied at Lafayette. It will be seen from this that one species—*Lachnosterna tristis*—invariably has a two-year cycle in the latitude of Lafayette while eleven species, namely *L. arcuata, fusca, vehemens, rugosa, ilicis, grandis, fraterna, hirticula, inversa, bipartita* and *congrua*, invariably have a three-year cycle according to our experiments. Two species, *L. crenulata* and *L. crassissima*, have a three-year life cycle as a rule but our experiments show that it may be extended in the latitude of Lafayette to four years, and several other species, *L. gibbosa, burmeisteri* and *implicita*, usually have a three-year cycle but in some cases it may be cut to two years. However, all of the *Lachnosterna* of economic importance in this latitude have a three-year cycle.

Latitude naturally has a great influence on the length of the life cycle of the same species. For instance, *L. grandis* has a life cycle of three years in the latitude of Lafayette but at Trout Lake in the northern end of Wisconsin, it undoubtedly has a four-year life cycle. We now have cages at this point started in 1914 and 1915 and the small size of the grubs this summer in cages started in 1914 is evidence enough to show that the grubs cannot mature in less than four years. Further in 1911 the beetles (mostly *L. grandis* with a few *L. dubia*) were very abundant and in 1912 and 1913 the grubs were unusually injurious to seedling conifers. In 1915 the beetles were again very abundant. Furthermore, the combined seasonal temperatures for

[1] Jour. Econ. Ent., Vol. 8, No. 1, 1915, p. 135–139, 3 pls.

Trout Lake for four years approximate the combined temperatures at Lafayette for three years. It is not improbable that we will find the length of the life cycle of *L. ulkei*, which is the southern analogue of *L. grandis*, to be but two years at Auburn, Alabama, where we have experiments started in collaboration with Dr. W. E. Hinds. From our present data it appears that the more important economic species in the southern states will have a two-year cycle. It is easy to understand why a species should have a three-year life cycle in the latitude of Indiana and a four-year cycle in northern Wisconsin, where the season is so short, and, on the other hand, why the same species, in the southern states where the growing season is much longer, should require but two years to complete its growth. It is, however, puzzling to find that the same species in the same cage may complete its cycle in two years in one case but require three years in another.

We have already established life-history cages in coöperation with various entomologists in different parts of the country and it is hoped that eventually we can have cages established in every state in the Union. In 1914 and 1915 we started a number of cages at Trout Lake, Wisconsin, in coöperation with the Wisconsin State Board of Forestry and Mr. W. D. Barnard in charge of the state nurseries at that point. The past spring we established cages at Auburn, Alabama, in coöperation with Dr. W. E. Hinds; at College Station, Texas, in coöperation first with Prof. Wilmon Newell and at the present with Prof. F. B. Paddock; and at Victoria, Texas, in coöperation with Mr. J. D. Mitchell, through the courtesy of Dr. W. D. Hunter. Life cycle cages have also been established at two stations of this division, namely at the Greenwood, Miss., station in charge of Mr. C. F. Turner and at Columbia, S. C., in charge of Mr. Philip Luginbill.

Briefly the life-history of the economic species of *Lachnosterna* in our latitude is as follows: The eggs are laid in the ground, most often in ground covered with vegetation such as blue grass, timothy and small grain, in balls of earth (Plate 14, fig. e), one egg in a cavity slightly larger than the egg, in the center of the earthen ball which is held loosely intact by a glutinous fluid secreted by the female. Individual females lay between 50 and 100 eggs or even more and our averages from many records in confinement, which probably do not offer ideal conditions, are more than 50 per female. The grubs hatching from these eggs several weeks later feed on tender rootlets and decaying vegetation in the ground until fall when they go deeper into the soil, forming a small earthern cell in which they pass the winter. They return to near the surface early in May of the following spring and it is this season that the grubs are most active feeding. The grubs discontinue feeding about the first of October of the second year, going

down into the soil where they again prepare an earthen cell to pass the second winter. Reappearing to near the surface in the spring of the third year they are actively feeding and may do some damage but usually by June 1 they are full grown, prepare an earthen cell and change to pupæ in July, having passed the two weeks or so previous to pupation in a semi-dormant stage which we may call the prepupal stage (Plate 14, fig. f). Remaining in the pupal stage three to four weeks, the adults issue and remain in the pupal cell through the following winter, appearing above the ground the last of April or first of May. In this brood there is really but one season where injury may be severe but in northern Wisconsin where the life cycle is four years, injury occurs throughout the two seasons following the year the eggs are laid. As stated above, the larvæ pupate during the summer or early fall in the case of the species of importance in the latitude of Indiana. However, in southern Indiana and farther south, we have a number of species which pupate in the spring, and appear above ground as beetles the same season, examples of such species being *L. burmeisteri*, *L.* n. sp. (*ephilida* group), *L. quercus*, *L. antennata* and *L. gracilis*. These species, like beetles of the genus *Cyclocephala*, do not make their appearance until the latter part of June or July. No doubt we will find that all of the *Lachnosterna* which appear comparatively late in the season in southern states, likewise pupate in the spring.

Comparison with Related Genera

It will be interesting here to briefly note the life-history of species belonging to related genera. *Ligyrus gibbosus* and *L. relictus* have a one-year life cycle, the beetles pupating and appearing above ground in fall and reëntering the ground to pass the winter, not laying eggs until the following spring. The beetles are present at lights almost the season through, due to the excessive overlapping of broods. The grubs feed on manure and other decaying matter but the beetle of *L. gibbosus* feeds on the roots of various weeds such as *Amaranthus* and *Helianthus* and not infrequently noticeably damages crops of sunflowers. An interesting habit of the *Ligyrus* beetles is that they copulate under ground. *Cyclocephala immaculata* is frequently found in compost heaps and in cultivated fields, and may obtain its full growth on decaying matter alone or may become a serious field pest, damaging crops similar to those attacked by *Lachnosterna* grubs. It has a one-year cycle but, like certain of the *Lachnosterna*, pupates in the spring and appears above the ground the latter part of June and during July. The beetle seems to feed only on decaying matter and does not feed on foliage as do the *Lachnosternas*. *Cotinis* (=*Allorhina*) *nitida* and the *Euphorias* likewise have a one-year cycle, the

former pupating in spring and appearing about the same time the *Cyclocephalas* are out, and the *Euphorias* maturing in fall and appearing above ground quite early in spring. The grubs of these two genera are interesting because they crawl on their backs and their normal food is decaying matter, particularly animal manures. The habits of the beetles likewise differ from those already discussed in that they fly during the day. All of the *Anomalas* which we have studied have a one-year life cycle, maturing in the fall and appearing above ground the following spring. Our observations indicate that the grubs feed on living rootlets but apparently they are never sufficiently abundant to noticeably damage crops although they may at any time prove important crop pests. In the beetle stage certain species feed on tender foliage and flowers at night while others are active during the day. The grubs of *Cotalpa lanigera* rank close to those of *Lachnosterna* in economic importance in some sections. In the "thumb district" of Michigan and along the lake in the vicinity of Holland, Michigan, these grubs are destructive to raspberry bushes, strawberries, corn, grass, etc. We have not yet completed our life-history studies of this species but the grubs in our cages started in 1914 were very small when examined this fall (1915) and it will take four years and possibly five years to complete the life cycle. *Polyphylla* grubs are more nearly like *Cotalpa* grubs in their habits and life-history. Grubs which proved to be those of *P. variolosa* were shown us by Dr. T. J. Headlee who reported them as destructive to crops in southern New Jersey and a supply of the grubs received from the farmer reporting the trouble showed many sizes, indicating a four- or five-year cycle for this species. *Phytalis* and *Listochelus*, species of which genera belong to the southern fauna, have similar habits and resemble the *Lachnosterna* grub but have not yet been studied enough by us to make generalizations.

So many have written for information to distinguish the different white grubs that it seems pertinent at this point to mention some of the more conspicuous characters to distinguish the grubs of *Lachnosterna* from those of related genera.

The *Lachnosterna* grub is white or cream white, the dark contents of the intestinal tract being plainly visible through the skin of the last few abdominal segments. The head is light tan in color, smooth and shiny and the body is covered with reddish brown hairs, those on the dorsum of the folds or ridges being short and more thickly placed. The ventral surface of the anal segment, which shows the most prominent character, bears a triangular patch of brownish hairs which are hooked at the tip, with an intermixing, especially at the borders of the patch, of fine, long hairs, and with a median longitudinal double row

of coarse hairs or spines inclined more or less inwardly. These rows may be straight and parallel or more or less curved; short or long; and the spines in the rows may be sparsely or closely placed according to species. The anal slit is in the form of an obtuse angle.

Grubs of other genera which resemble the *Lachnosterna* grubs by having the two rows of spines on the underside of the last abdominal segment are *Anomala*, *Phytalis*, *Listochelus*, *Polyphylla*, *Euphoria*, and *Cotinis* (=*Allorhina*).

The living larvæ of *Euphoria* and *Cotinis* are at once separable because of their dorsal locomotion. The relatively small head which is finely reticulated, short legs, the transverse anal slit, two rows of unusually stout spines on the ventral surface of the anal segment and the straight hairs and spines on the same segment at once separate grubs of these genera from grubs of *Lachnosterna*. *Euphoria* grubs differ from those of *Cotinis* by their smaller size; the spines of the two median longitudinal rows on the anal segment are directed inwardly and are not so thick or stout, and the ventral surface of the anal segment is not uniformly clothed with hairs, there being bare spaces not to be found in *Cotinis*.

Polyphylla grubs are noticeably larger than those of *Lachnosterna*, when mature, the head is darker, and has a slight roughened reticulation. The two rows of stout spines, about ten spines in each row, on the under surface of the anal segment are short, being about a third the length of the segment and the upper surface of the anal segment is thickly covered with fine recumbent hairs. The anal slit is obtuse.

The grubs of *Anomala*, *Listochelus* and *Phytalis* are very close to those of *Lachnosterna* and we are at present unable to satisfactorily distinguish between grubs of these four genera except by direct comparison but no doubt substantial characters will be found when we obtain a sufficient number of grubs of the first three mentioned genera.

Grubs of such common species as *Trichius piger*, *Cotalpa lanigera*, *Ligyrus relictus*, *L. gibbosus*, *Osmoderma eremicola*, *Cyclocephala* spp. *Dyscinetus trachypygus* and *Stratægus antæus* are sometimes mistaken for grubs of the genus *Lachnosterna* but may at once be separated by the absence of the two rows of spines on the ventral surface of the anal segment and all of these species have a transverse anal slit.

Cyclocephala and *Cotalpa* are the most likely to be confused because they are found in fields with *Lachnosterna* grubs and attack the same crops. *Cyclocephala* grubs have a rather smooth light brown colored head which is inconspicuously reticulated. The spines on the underside of the anal segment are sparsely and uniformly placed, moderately long, and hooked. *Cotalpa* grubs have a brownish or tan colored head which is very slightly and noticeably reticulated and the under surface

of the anal segment bears rather thickly placed hooked spines, intermixed with a few long hairs. The dorsal surface of the anal segment is smooth in the middle, the sides and tip with a mixture of long and short, moderately erect hairs.

The grubs of *Ligyrus gibbosus* agree closely with those of *Cyclocephala* but the reticulation of the head is slightly more roughened, and the hairs or spines on the ventral surface of the anal segment are remarkably short, they are not hooked, and are more closely placed.

Ligyrus relictus is a more robust grub, the posterior abdominal segments being much enlarged and giving the grub a characteristic appearance. The head is small, dark brown and its surface reticulate. The ventral surface of the anal segment bears a patch of sparsely and irregularly placed short spines intermixed with a few longer hairs, and the dorsal surface of this segment bears only a few short spines and hairs.

The grubs of *Osmoderma eremicola* have a moderately light brown head and the mandibles and head at the base of mandibles are jet black. The ventral surface of the anal segment is covered with heavy spines, intermixed at the sides and extremities with longer hairs. The upper surface of this segment bears moderately short, uniformly placed, recumbent hairs.

Stratægus antæus grubs are at once distinguished from other grubs mentioned above by the dark reddish brown head which is uniformly punctured with rather deep pits. The under surface of the last abdominal segment bears many spines which are slightly inclined caudad, the border of the patch of spines intermixed with longer hairs and the upper surface of same segment with moderately sparsely placed recumbent hairs.

Trichius piger grubs are small and have a pale brown head with an inconspicuous reticulation. The dorsal and ventral surfaces of the anal segment bear an irregular scattering of short spines and rather long hairs.

Dyscinetus trachypygus has a dark brown head which is inconspicuously reticulate and covered with irregularly placed fine punctures, in this respect differing from all species mentioned above, excepting *Stratægus*, the head of which is much more coarsely punctate and the species is much larger. The ventral surface of the anal segment bears a patch of hooked spines and the upper surface of the same segment is covered, excepting along the longitudinal median line, with fine hairs, those at the tip being shorter, stouter and more spine-like.

Field Observations

The distribution of the many species is being worked out as rapidly as the collections being received will permit. We have records of

over 300,000 determined *Lachnosterna* beetles but there are many localities where scarcely any records are represented in our collections and many more collections, especially from southern states and from various sections of the other states, must be made before we can come to definite and satisfactory conclusions for the country as a whole. Any one who can collect beetles at trees or lights are urged to so notify us that we may offer all assistance possible. Our records, especially where continuous collections have been made, are very interesting, showing some species to occur at certain elevations, others where certain soil conditions exist, while still others are present only where foliage of a particular tree is available. Certain species such as *tristis*, *hirticula*, *fraterna*, etc., feed largely on hickory and oak, while others, usually beetles of the *fusca* group, prefer ash, and others, such as *gibbosa*, are general feeders. *Lachnosterna vehemens* is found at Lafayette almost exclusively in the bottom land area along the Wabash river and although supposed to be a comparatively rare species it is the predominant species at Elk Point, South Dakota, as found by Mr. C. N. Ainslie and the writer, in the fertile bottom land between the Missouri and Sioux rivers. Where we have found it behind the plow or in our beetle collections, it has been where the land is low, usually the bottom land along a river. Soil conditions also influence the abundance of certain species. While it is a well known fact that most species prefer a "timber soil," usually a clay loam soil, others have a decidedly different preference, for we find *L. prunina* invariably where the soil is sandy.

The time and length of the period of flight for the different species of *Lachnosterna* varies considerably. For instance, at Lafayette, *gibbosa* is one of the first to make its appearance in spring, and the last to disappear, and while such species as *arcuata* and *fusca* appear equally early they disappear more rapidly towards the latter half of June. Most of the species appear within a few days after the first flight of beetles but the delayed appearance of some species, such as *implicita*, *crenulata* and *ilicis*, is very pronounced, for instance, *implicita* seldom makes its appearance until the middle of May and disappears considerably earlier than most species. On the other hand, *tristis* is one of the first species to be found but by the first of June it has become a very rare species at both lights and trees. In the latitude of Lafayette, beetles first appear the latter part of April or first of May, usually the former, and reach a maximum abundance near or a little after the middle of May, gradually diminishing in numbers thereafter until July 1, after which date only straggling individuals are to be found. In southern Indiana and farther south, certain species, such as *L. ephilida*, *burmeisteri*, *quercus*, *gracilis*, etc.,

do not normally make their appearance until late June, occurring throughout the month of July and into August. From these notes it will be noticed that certain species are active above ground two months or more, while others disappear after three or four weeks. The longer period of existence is due to a longer period of life, and not to a succession of beetles, for in our cages where individual pairs were confined the length of life of the beetles coincided with the occurrence of the same species out-of-doors.

It is interesting to note the predominant species in different localities where grubs are of considerable economic importance. In the west—Utah, Idaho and Montana—the *Lachnosternas* are beginning to make their appearance as pests of importance and here the species involved is *L. dubia*. In the southeastern corner of South Dakota, the grubs have become very serious pests and here *L. vehemens* predominates. In northeastern Iowa, southwestern Wisconsin and northwestern Illinois, a center of a very heavy infestation and in an unglaciated region, we have *L. fusca* as the predominant species. *L. rugosa* is the dominant species in south central Wisconsin, being confined to the glaciated portion of the state, while a little farther to the east, in the vicinity of Beaver Dam, *L. fusca* again becomes the prevalent one. In the state forest nurseries of Minnesota and Wisconsin, the former at Lake Itasca and the latter at the extreme north border of Wisconsin in Vilas County, considerable trouble has been experienced with white grubs and at both of these places *L. grandis* is the predominant species. In the southwestern part of Michigan in and about Kalamazoo County the 1914 brood was a destructive one and here the predominant species is *L. hirticula* although *fusca* is also a common species. South and east of this infested district, that is, south of Battle Creek, we have another occurrence of *hirticula* but of a different brood, the date for the next flight of beetles in this district being 1916. In the "thumb district" of Michigan and on south into Ohio the 1914 brood was very important and it is interesting to note that here again in the glaciated area *L. rugosa* is decidedly the predominant species, but going a little east into Ohio the species doing the damage are *hirticula* and *fusca*, the former being the more common, according to our observations, in the center of the infested area. Continuing eastward into Maryland, *hirticula* again appears as the important species while in the infested counties of New York *dubia* and *fusca* are the two common ones. Going south we find *congrua* and *crassissima* are injurious species in Missouri while in Kansas wheat is attacked by white grubs mostly of the species *lanceolata* and *crassissima*. In the central part of Texas (Travis County), a great deal of damage to corn, cotton, and grasslands by grubs of *L. torta* has been reported.

By far the most serious and widespread white grub outbreaks on record are those of 1912 and 1915, the beetles for these broods occurring in the years 1911 and 1914, respectively. The area of these infestations included southeastern South Dakota, northwestern and northeastern Iowa, southeastern Minnesota, southern Wisconsin, northern Illinois, the extreme northwestern corner of Indiana, southwestern Michigan as well as the eastern portion of that state from the "thumb district" south into Ohio; also many points in the northern third of Ohio, western Maryland, northwestern and northeastern Pennsylvania, southeastern New York, including Long Island, and Connecticut. A less serious outbreak occurred in most of the above mentioned territory in 1909, but that of 1912 was very severe while the 1915 infestation was even more general and severe to cultivated crops, showing a gradual increase in the abundance of grubs and in the area infested. Although the grubs were more abundant and showed greater damage to cultivated crops in 1915, the grass crops were noticeably less injured, owing to the excessive rains throughout the summer. It was not an uncommon sight to see thirty- or forty-acre fields of corn totally destroyed and more often than otherwise the corn fields in the infested districts were 50 per cent destroyed. The accompanying photographs (Pl. 15) give a fair idea of the appearance of the infested fields in Wisconsin, Illinois and Iowa, although they do not impress one with the great amount of damage actually caused by the grubs. The various natural enemies now seem to be making headway in controlling the grubs and the crest of this destructive brood has probably been reached but it will be many years before the brood again becomes normal unless some unforeseen calamity overtakes it.

In 1911 the beetles were extremely abundant and stripped the timber of its foliage according to reports and during the latter part of May and the first of June in 1914 we made a trip across the northern end of Illinois, northeastern Iowa, southern Wisconsin as far north as Baraboo, thence east to Milwaukee, and through parts of Michigan, and everywhere, excepting in eastern Wisconsin, the timber, which consisted chiefly of oak and hickory, was completely stripped of its foliage. Only red oak, the maples, conifers and fruit trees were left with an appreciable amount of foliage, and the accompanying photographs (Pl. 16) illustrate the degree of defoliation which we found in the infested localities. To further illustrate—the beetles were so abundant that the dead ones accumulating beneath the lights had to be swept away each morning to prevent or at least modify the terrible stench which they produced. At one small town in Wisconsin the beetles accumulating beneath the ten arc lights of the town were hauled away each morning for a period of ten days or two weeks, by the wagon load.

Natural Enemies

Insect Enemies of Grubs.—Of the several insect enemies of white grubs, the *Tiphias* and *Asilids* are the most effective checks, according to our observations. In the genus *Tiphia* are several species attacking grubs, and of these we have worked out the life-history of two, neither of which has yet been specifically determined. Both have a one-year life cycle, passing the winter as larvæ within the cocoons, are parthenogenetic and paralyze the grub only temporarily, that is, only about long enough to deposit an egg. One of the species lays its egg on the dorsum of the thoracic segments of the grub while the other lays its egg on the underside of the abdominal segments.

Elis 5-cincta[1] and probably several other species of the genus are important enemies of the grub in some localities. The wasp has a one-year life cycle, it is not parthenogenetic according to our observations, and differs noticeably from *Tiphia* in that it paralyzes the grub completely, a paralyzed grub never coming back to active life although it remains inertly alive for several weeks to a month or more.

Three tachinids are parasitic on the grubs, all attacking it in a similar manner. These are *Microphthalma disjuncta*[2] which is common in the central western states, *M. pruinosa*[2] in the New England states, and *Ptilodexia tibialis*[2] in Texas.

Of the asilid enemies we have reared but one species, *Promachus vertebratus*, from larvæ actually observed feeding on grubs, and in certain parts of Wisconsin this is a prominent grub enemy. In the East the analogue of this species, according to Doctor Felt's observations, is *Promachus fitchii*. Both of these species appear to have a three-year life cycle, thus following the cycle of the grub. We have reared other asilids from grub infested fields but we have no absolute proof as to their predaceous habits excepting circumstantial evidence.

Several species of carabid beetles and their larvæ are predaceous on white grubs and the rôle they play in the control of grubs is probably greater than has heretofore been supposed.

Three insect enemies of minor importance have been previously reported, namely, *Pelecinus polyturator*, *Ophion bifoveolatum*, and *Sparnopolius fulvus*, thus bringing the total number of insect enemies of the grub to more than twelve species.

Insect Enemies of Beetles.—We have reared five dipterous parasites of the adult May-beetles, all of which have been previously reported as parasitic on May-beetles, and are *Pyrgota undata*, *P. valida*, *Cryptomeigenia theutis*,[2] *Eutrixa exile*,[2] and *Biomyia lachnosternæ*.[2]

[1] Gahan and Rohwer det.

[2] Walton det.

TABLE I. SUMMARY HISTORY OF CERTAIN SPECIES OF LACHNOSTERNA. LAFAYETTE, INDIANA

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
28	*L. arcuata*	12" flower pot	May 11, 1911	July 1913	Spring, 1914	3 yrs.	1	July 25, 1913	2 pupae { a	....	Pupa preserved	..	
									b	....	Aug. 12, 1913	♀	
32	*L. arcuata*	12" flower pot	May 19, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 26, 1913	1 larva	Aug. 2, 1913	Aug. 29, 1913	♀	
53	*L. arcuata*	Bronze wire cloth 20" diam. 4 ft. deep	June 1, 1911	? Aug. 1913	Spring, 1914	3 yrs.	1	Aug. 6, 1913	3 pupae { a and b	....	2 pupae preserved		
									c	....	Aug. 28, 1913	♀	
102	*L. arcuata*	Pearl wire cloth 20" diam., 2½ ft. deep	May 7, 1912	July 1914	Spring, 1915	3 yrs.	9	July 22, 1914	10 pupae { a	....	Aug. 7, 1914	♀	
									b	....	Aug. 17, 1914	♂	
									c	....	Aug. 11, 1914	♂	
									d	....	Aug. 7, 1914	♀	
									e	....	Aug. 13, 1914	♂	
									f	....	Aug. 15, 1914	♀	
									g	....	Aug. 13, 1914	♀	
									h	....	Aug. 14, 1914	♂	
									j-k	....	2 pupae preserved	..	
									1 larva i	July 26, 1914	Aug. 22, 1914	♀	
119	*L. arcuata*	16" flower pot	May 25, 1912	July 1914	Spring, 1915	3 yrs.	2	July 13, 1914	3 pupae { a	....	Aug. 9, 1914	♀	
									b	....	Aug. 9, 1914	♂	
									c	....	1 pupa preserved	..	
									2 larvae { d	Preserved July 18, 1914			
									e	Preserved July 18, 1914			
127	*L. arcuata*	15" flower pot	June 2, 1912	June and July 1914	Spring, 1915	3 yrs.		July 16, 1914	8 pupae { a	....	Aug. 12, 1914	♂	
									b	....	Aug. 9, 1914	♂	
									c	....	Aug. 8, 1914	♂	
									d	....	Aug. 12, 1914	♀	
									e	....	Aug. 11, 1914	♀	
									f	....	Aug. 12, 1914	♂	
									g	....	Aug. 8, 1914	♀	
									x	....	1 pupa preserved	..	
									5 larvae { h	July 17, 1914	Aug. 13, 1914	♂	
									i	July 22, 1914	Aug. 17, 1914	♀	
									j	July 20, 1914	Aug. 17, 1914	♀	
									k	July 18, 1914	Aug. 17, 1914	♂	
									l	July 19, 1914	Aug. 14, 1914	♀	
202	*L. bipartita*	20" galv. iron cage, 2½ ft. deep	May 1913	? Aug. 1915	Spring, 1916	3 yrs.	0	Aug. 9, 1915	1 pupa	....	Pupa died before maturing	..	

211	*L. burmeisteri*	20" galv. iron cage, 2½ ft. deep	July 18, 1913	—— 1915	Summer, 1915	2 yrs.	11+	Aug. 5, 1915	4 adult ♂ and 2 larvæ found July 30, 1915				The larvæ passing the winter 1915–16 will undoubtedly pupate next spring and issue the same year hence we have an instance of the same species having a 2- and 3-year life cycle in the same cage
					Summer, 1916	3 yrs.			2 larvæ a	Preserved			
									b	Passed winter 1915–16 as larva			
									7 adults (1♂, 6♀) and 3 larvæ found Aug. 5, 1915				
									3 larvæ Aug. 5 a, b, c	Passed winter of 1915–16 as larvæ			
226	*L. burmeisteri*	—" flower pot	Aug. 19, 1913	....	Summer, 1915	2 yrs.	1+	Aug. 18, 1915	1 dead adult above ground which issued this spring	....	....		
					? Summer, 1916	3 yrs.			1 larva	Passing winter of 1915–16 as larva			
204	*L. congrua*	20" galv. iron cage, 2½ ft. deep	May 22, 1913	Aug. 1915	Spring, 1916	3 yrs.	0	Aug. 6, 1915	1 pupa	....	Preserved		
									10 larvæ a	Aug. 23, 1915	Preserved		
									b	Died Aug. 23			
									c	Aug. 22, 1915	Preserved		
									d	Died Sept. 4			
									e	Died Aug. 19			
									f	Died			
									g	Died			
									h, i, j	Crushed and preserved			
221	*L. crassissima*	15" flower pot	May 22, 1913	Jul.–Aug. 1915	Spring, 1916	3 yrs.	2+	July 19, 1915	11 larvæ a	Died			d and f passing winter as larvæ and it therefore appears that we have an instance of a variation in life cycle with the same species in the same cage
				? —— 1916	? 1917	? 4 yrs.			b	Aug. 3, 1915	Sept. 18, 1915	♂	
									c	Died			
									d				
									e	July 31, 1915	Died	♂	
									f				
									g	Aug. 7, 1915	Sept. 21, 1915	♀	
									h	Died			
									i	Aug. 24, 1915	Killed by fungus	♂	
									j	Died			
									k	Preserved			
43	*L. crenulata*	12" flower pot	May 24, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 29, 1913	2 larvæ a	Aug. 5, 1913	Aug. 29, 1913	♂	
									b	Aug. 6, 1913	1 pupa preserved, Aug. 17	..	

TABLE I—*Continued*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
50	*L. crenulata*	12" flower pot	June 9, 1911	Aug. 1913	Spring, 1914	3 yrs.	1	July 30, 1913	1 larva	Aug. 6, 1913	Aug. 30, 1913	♂	
126	*L. crenulata*	15" flower pot	June 6, 1912	July 1914	Spring, 1915	3 yrs.	8	July 16, 1914	9 larvæ { a b c d e f g h i	July 18, 1914 July 20, 1914 July 22, 1914 July 21, 1914 July 21, 1914 July 25, 1914 July 22, 1914 1 larva p'served July 19, 1914	Aug. 12?,1914 Aug. 14, 1914 Aug. 17, 1914 Aug. 14, 1914 Aug. 15, 1914 Aug. 20, 1914 Aug. 17, 1914 Aug. 13, 1914	.. ♀ ♀ ♂ ♂ ♀ ♀ .. ♀	
112	*L. crenulata*	20" pearl wire cage, 2½ ft. deep	June 1, 1912	July 1915	Spring, 1916	4 yrs.	1	July 21, 1914	3 larvæ { a b c	July 1915 Died Oct. 6, '14 Died July 24,'14	July 29, 1915	♂	
220	*L. crenulata*	15" flower pot	May 21, 1913	? July 1915	Spring, 1916	3 yrs. 4 yrs.	1+	July 31, 1915	2 pupæ { a b 2 larvæ { c d	.... Passed winter 1915–16 as larvæ Preserved	Preserved Sept. 9, 1915	♀	This larva (c) will undoubtedly transform in 1916. Here we have an instance where the same species in the same cage may have a 3- or 4-year life cycle
104	*L. fraterna*	Pearl wire 20" diam., 2½ ft. deep	May 19, 1912	July 1914	Spring, 1915	3 yrs.	1	July 22, 1914	1 pupa 1 larva	.... Died Aug. 7, '14	Aug. 15, 1914	♀ ..	
110	*L. fusca*	Pearl wire 20" diam., 2½ ft. deep	May 28, 1912	July 1914	Spring, 1915	3 yrs.	1	July 18, 1914	1 pupa 3 larvæ { a b c	.... July 21, 1914 July 20, 1914 Larva preserv'd	1 pupa preserved Aug. 19, 1914 Pupæ preserved	.. ♀ ..	
113	*L. fusca*	Pearl wire 20" diam., 2½ ft. deep	June 2, 1912	July 1914	Spring, 1915	3 yrs.	1	July 21, 1914	1 pupa 3 larvæ { a b c	.... Larva preserv'd July 25, 1914 Larva preserv'd	Aug. 19, 1914 .... D. before issuing	♂ .. ♂ ..	
213	*L. fusca*	15" flower pot	May 13, 1913	July 1915	Spring, 1916	3 yrs.	1	July 31, 1915	2 pupæ { a b	....	Died Aug. 9 Sept. 11, 1915	.. ♀	

30	*L. gibbosa*	12" flower pot	May 12, 1911	July 1913	Spring, 1914	3 yrs.	3	July 26, 1913	3 pupae	a	....	1 pupa preserved	..
										b	....	Aug. 2, 1913	♂
										c	....	Aug. 6, 1913	♀
									1 larva		July 30, 1913	Aug. 27, 1913	♂
60	*L. gibbosa*	12" flower pot	June 1911	July 1913	Spring, 1914	3 yrs.	1	July 23, 1913	1 pupa		....	Aug. 20, 1913	♂
108	*L. gibbosa*	Pearl wire 20" diam., 2½ ft. deep	May 7, 1912	July 1914	Spring, 1915	3 yrs.	12	July 22, 1914	11 pupae	a	....	Aug. 5, 1914	♂
										b	....	Aug. 7, 1914	♀
										c	....	1 pupa preserved	..
										d	....	1 pupa preserved	..
										e	....	Aug. 15, 1914	♂
										f	....	Aug. 7, 1914	♀
										g	....	Aug. 10, 1914	♂
										h	....	Aug. 6, 1914	♀
										i	....	Aug. 13, 1914	♀
										j	....	Aug. 13, 1914	♂
										k	....	Aug. 4, 1914	♀
									4 larvae	l	1 larva preser'd	....	..
										m	July 28, 1914	Aug. 21, 1914	♀
										n	July 25, 1914	Aug. 18, 1914	♂
										o	July 27, 1914	Aug. 21, 1914	♂
109	*L. gibbosa*	Pearl wire 20" diam., 2½ ft. deep	May 21, 1912	July 1914	Spring, 1915	3 yrs.	7	July 17, 1914	5 pupae	a	....	Aug. 7, 1914	♂
										b	....	Aug. 10, 1914	♂
										c	....	Aug. 10, 1914	♂
										x, y	....	2 pupae preserved	..
									4 larvae	d	July 21, 1914	Aug. 14, 1914	♀
										e	July 23, 1914	Aug. 20, 1914	♀
										f	July 20, 1914	Aug. 15, 1914	♂
										g	July 227, 1914	Aug. 17, 1914	♀
116	*L. gibbosa*	16" flower pot	May 15, 1912	July 1914	Spring, 1915	3 yrs.	4	July 14, 1914	1 pupa		....	Preserved	..
									7 larvae	a	Preserved	....	..
										b	July 20, 1914	Aug. 14, 1914	♂
										c	July 18, 1914	Aug. 12, 1914	♀
										d	July 16, 1914	Aug. 9, 1914	♂
										e	July 23, 1914	D'd Aug. 28, 1914	♀
										f	July 16, 1914	Aug. 9, 1914	♀
										g	Preserved	....	..
111	*L. gibbosa*	16" flower pot	May 15, 1912		Spring, 1914	2 yrs.		July 15, 1914	At least 3 ♂ and 3 ♀ *L. gibbosa* which issued the past spring and had died in the cage. Not only were the cast pupal skins found but also 35 recently hatched grubs, thus proving beyond doubt a 2-year life cycle in this instance				
205	*L. grandis*	20" galv. iron cage, 2½ ft. deep	June 1, 1913	July 1915	Spring, 1916	3 yrs.	1	Aug. 6, 1915	2 pupae	a	....	Aug. 27, 1915	♀
										b	....	Pupa preserved	♀
54	*L. hirticula*	20" brass cloth cage, 4 ft. deep	June 7, 1911	? July 1913	Spring, 1914	3 yrs.	0	Aug. 6, 1913	2 pupae		....	Both pupae preserved	

Table I—*Continued*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
62	*L. hirticula*	Shallow 12" pot	June 1911	....	Spring, 1914	3 yrs.	0	July 11, 1913	1 larva	In prepupal stage	Preserved		
107	*L. hirticula*	20" pearl wire cage, 2½ ft. deep	May 25, 1912	July 1914	Spring, 1915	3 yrs.	5	July 21, 1914	6 pupæ a	....	Aug. 17, 1914	♂	
									b	....	Died July 27	..	
									c	....	Aug. 12, 1914	♂	
									d	....	Died Aug. 3	..	
									e	....	Aug. 19, 1914	♂	
									f	....	Preserved	..	
									2 larvæ g	July 22, 1914	Aug. 19, 1914	♀	
									h	July 25, 1914	Aug. 22, 1914	♀	
129	*L. hirticula*	15" flower pot	June 2, 1912	July 1914	Spring, 1915	3 yrs.	0	July 17, 1914	1 larva	July 22, 1914	Died in pupa stage	..	
41	*L. ilicis*	12" flower pot	May 23, 1911	? July 1913	Spring, 1914	3 yrs.	1	July 29, 1914	1 pupa	....	Aug. 5, 1913	♂	
130	*L. ilicis*	15" flower pot	May 22, 1912	July 1914	Spring, 1915	3 yrs.	1	July 12, 1914	1 larva	July 26, 1914	Aug. 31, 1914	♀	
106	*L. implicita*	20" pearl wire cage, 2½ ft. deep	May 24, 1912	July 1914	Spring, 1915	3 yrs.	0	July 20, 1914	2 pupæ a	....	Preserved	..	
									b	....	Preserved	..	
									2 larvæ c	....	Preserved	..	
									d	....	Preserved	..	
128	*L. implicita*	15" flower pot	June 2, 1912	? 1913	Spring, ? 1914	? 2 yrs.	0	July 15, 1914	Found neither grubs, pupæ or adults but found 2 pupal skins and remains of beetles indicating strongly a 2-year life cycle in this instance				
122	*L. inversa*	15" flower pot	June 4, 1912	July 1914	Spring, 1915	3 yrs.	1	July 13, 1914	1 larva	July 17, 1914	Aug. 12, 1914	♂	
123	*L. inversa*	16" flower pot	May 9, 1913	? July 1915	Spring, 1916	3 yrs.	5	Aug. 2, 1915	11 pupæ a	....	Died	♂	
									b	....	Sept. 6, 1915	♂	
									c	....	Died	..	
									d	....	Aug. 23, 1915	♀	
									e	....	Aug. 23, 1915	♂	
									f	....	Aug. 28, 1915	♂	
									g	....	Aug. 25, 1915	♂	
									h, i, j	....	Preserved	..	
200	*L. inversa*	20" galv. iron cage, 2½ ft. deep	May 13, 1913	? July 1915	Spring, 1916	3 yrs.	4	Aug. 9, 1915	8 pupæ a	....	Aug. 26, 1915	♀	
									b	....	Aug. 28, 1915	♂	
									c	....	Aug. 28, 1915	♀	
									d	....	Preserved	♀	
									e	....	Aug. 24, 1915	♀	
									f	....	No record	..	
									g, h	....	Preserved	..	

207	*L. lanceolata*	20" galv. iron cage, 2½ ft. deep	June 23, 1913		....	? 2 yrs.	1	Aug. 6, 1915	1 ♀ adult		When examined Apr. 6, 1915, found one grub near surface which is preserved and when thoroughly examined Aug. 6, find one beetle above ground, indicating a 2- and possibly a 3-year life cycle in some cases		♀
55	*L. rugosa*	20" tile, 4 ft. deep	June 7, 1911	? July 1913	Spring, 1914	3 yrs.	2	Aug. 4, 1913	6 pupæ	a	....	Aug. 31, 1913	♀
										b	....	?	♂
										c	....	Preserved	..
										d, e, f	....	Preserved	..
111	*L. rugosa*	20" pearl wire cage, 2½ ft. deep	May 28, 1912	July 1914	Spring, 1915	3 yrs.	2	July 18, 1914	4 pupæ	a	....	Aug. 15, 1914	♀
										b	....	Aug. 9, 1914	♂
										c	....	Preserved	..
										d	....	Preserved	..
									1 larva	e	Preserved	....	..
117	*L. rugosa*	16" flower pot	May 21, 1912	July 1914	Spring, 1915	3 yrs.	0	July 14, 1914	1 larva		July 20, 1914	Pupa matured but failed to issue	♀
125	*L. rugosa*	15" flower pot	June 6, 1912	July 1914	Spring, 1915	3 yrs.	6	July 15, 1914	4 pupæ	a	....	Aug. 6, 1914	♀
										b	....	Aug. 7, 1914	♂
										c	....	Aug. 6, 1914	♀
										d	....	?	♂
									3 larvæ	e	July 17, 1914	Ad'lt, failed to iss'.	♀
										f	July 17, 1914	Aug. 11, 1914	♂
										g	Preserved	....	.
30	*L. tristis*	12" flower pot	May 13, 1911	....	Spring, 1913	2 yrs.	1	Sept. 23, 1913	1 adult		....	....	♀
31	*L. tristis*	12" flower pot	May 17, 1911	....	Spring, 1913	2 yrs.	2	Sept. 23, 1913	2 adults		....	....	♂ ♀
131	*L. tristis*	15" flower pot	May 22, 1912	? July 1913	Spring, 1914	2 yrs.	0	Aug. 8, 1913	1 pupa		....	Preserved	..
121	*L. vehemens*	16" flower pot	June 4, 1912	July 1914	Spring, 1915	3 yrs.	7	July 13, 1914	7 pupæ	a	....	Aug. 7, 1914	♀
										b	....	Aug. 10, 1914	♂
										c	....	Aug. 10, 1914	♂
										d	....	Aug. 8, 1914	?
										e	....	Aug. 7, 1914	♂
										f	....	Aug. 7, 1914	♀
										g	....	Preserved	..
									1 larva		July 14, 1914	Aug. 10, 1914	♀

TABLE I—*Concluded*

Cage No.	Species	Style of Cage	Date Started	Mo. and Yr. of Pupation	Date Beetles Would Issue	Total Life Cycle	No. Adults Reared	Date Cage Was Completely Examined	Number Specimen Found	Date of Pupation	Date Issued as Adult	Sex	Remarks
132	*L. vehemens*	15" flower pot	May 22, 1912	July 1914	Spring, 1915	3 yrs.	6	July 17, 1914	6 pupæ a	....	Aug. 12, 1914	♀	
									b	....	Aug. 10, 1914	♂	
									c	....	Aug. 11, 1914	♂	
									d	....	Aug. 11, 1914	♀	
									e	....	Preserved	..	
									f	....	Preserved	..	
									3 larvæ g	July 19, 1914	Aug. 17, 1914	♀	
									h	July 20, 1914	Aug. 18, 1914	♀	
									i	Preserved	....	..	
215	*L. vehemens*	15" flower pot	May 13, 1913	? July 1915	Spring, 1916	3 yrs.	7	Aug. 5, 1915	8 pupæ a	....	Aug. 23, 1915	♂	
									b	....	Aug. 23, 1915	♂	
									c	....	Aug. 26, 1915	♂	
									d	....	Aug. 21, 1915	♂	
									e	....	Sept. 2, 1915	♀	
									f	....	Aug. 31, 1915	♂	
									g	....	Sept. 6, 1915	♀	
									h	....	Preserved	..	

The last is the species referred to by Dr. Forbes as *Viviana* sp. on p. 475 of bulletin 116 of the Illinois Agricultural Experiment Station.

MISCELLANEOUS ENEMIES.—Spiders are quite predatory on beetles often catching them in their webs but not infrequently actually capturing the beetle as it feeds at night. Mites are very troublesome in cages where they attack grubs and occasionally we find them sufficiently numerous on grubs in the field to cause their death.

Animals such as skunks and opossums are well-known enemies of grubs and do their share towards holding them in check, while many birds, and especially crows and blackbirds, are equally well known for their fondness for white grubs.

DISEASES.—Four types of grub diseases are known, these being of fungus, bacterial, protozoan and nematode origin, respectively. Among the fungus diseases the best known are the *Cordyceps* because of the peculiar growth which they cause. The green muscardine fungus (*Metarrhizium anisopliæ*) is almost equally well known as an insect fungus disease and although it seems to have been successfully used artificially for the control of some insects, it has never proven satisfactory nor even given an indication of proving satisfactory against white grubs.

Of the several recognized bacterial diseases none have shown any indication of proving effective in the control of the white grub.

We have observed two outbreaks of a protozoan disease of white grubs which has apparently effectively controlled the grub in certain localities. It was first observed at Hoopeston, Illinois, by Mr. W. P. Flint and the writer (Oct. 1912) and later (Oct. 1915) by the writer at Belvidere, Illinois. In both cases the diseased grubs came to the surface or to near the surface of the ground where they died.

At Lancaster, Wisconsin, we found a number of fields in 1915 which were apparently cleared or at least practically cleared of grubs by a nematode "disease," an affection which seemed to be assisted greatly by the wet season.

METHODS OF CONTROL

UTILIZING FARM ANIMALS.—Hogs have been employed as a means of clearing fields of white grubs for many years and where they can conveniently be turned into an infested field this is the surest and quickest method that may be employed. When the infested field is being plowed, if before the grubs have gone deep into the ground or after the grubs have returned to near the surface in the spring, hogs should be allowed the run of the field. Likewise chickens and turkeys should be trained to follow the plow, harrow, and cultivator in fields located near the farm buildings. We have known of fifteen-acre

fields being cleared of a heavy infestation of grubs by permitting the chickens the run of the field during cultivation.

Fall Plowing.—Plowing just previous to the time the grubs go deep into the ground to pass the winter will destroy many of them and should be practiced whenever possible but it should not be considered a panacea for the grubs. Fall plowing the year the grubs are changing to beetles, especially early fall plowing and the sooner after July 15 the better, is very effective in destroying the grubs as they are transforming to pupæ, the pupæ themselves and the recently issued beetles. If the cells containing prepupæ, pupæ and recently issued beetles are broken, the insect within will almost invariably be destroyed and it is therefore important to use a plow which will break up the soil as it is overturned, or if this is not possible the ground should be deeply disked after plowing in order to break up the soil. In 1916 early fall plowing will be especially helpful in the localities where grubs were so destructive in 1915 and where entire communities can follow this practice much benefit will result.

Rotation of Crops.—A rotation to avoid grub injury is of greatest importance but it is essential that the farmer be acquainted with the life-history and habits of the insect in order to intelligently adopt a rotation which will not only be effective in preventing grub injury but which will be best suited to his conditions. We know the beetles prefer a ground covered with vegetation for the deposition of their eggs, hence, other conditions being equal, most of the eggs will be laid in timothy, blue grass, and small grain fields. Consequently, the year following a large flight of beetles, such ground should not be planted to the more susceptible crops such as corn and potatoes. On the other hand, land which was in corn or other wide-row crops and kept thoroughly cultivated during the flight of the beetles will ordinarily have few grubs and hence such land should be used the following year for the crops most susceptible to grub injury, that is for corn, potatoes, beans, etc. A rotation of oats, clover and corn has proven very satisfactory in some sections. Our observations indicate that ground with a heavy stand of pure clover when the beetles are flying will ordinarily contain few grubs since the beetles will not seek such land for egg-laying. Clover, if planted in the fall and allowed to make a good

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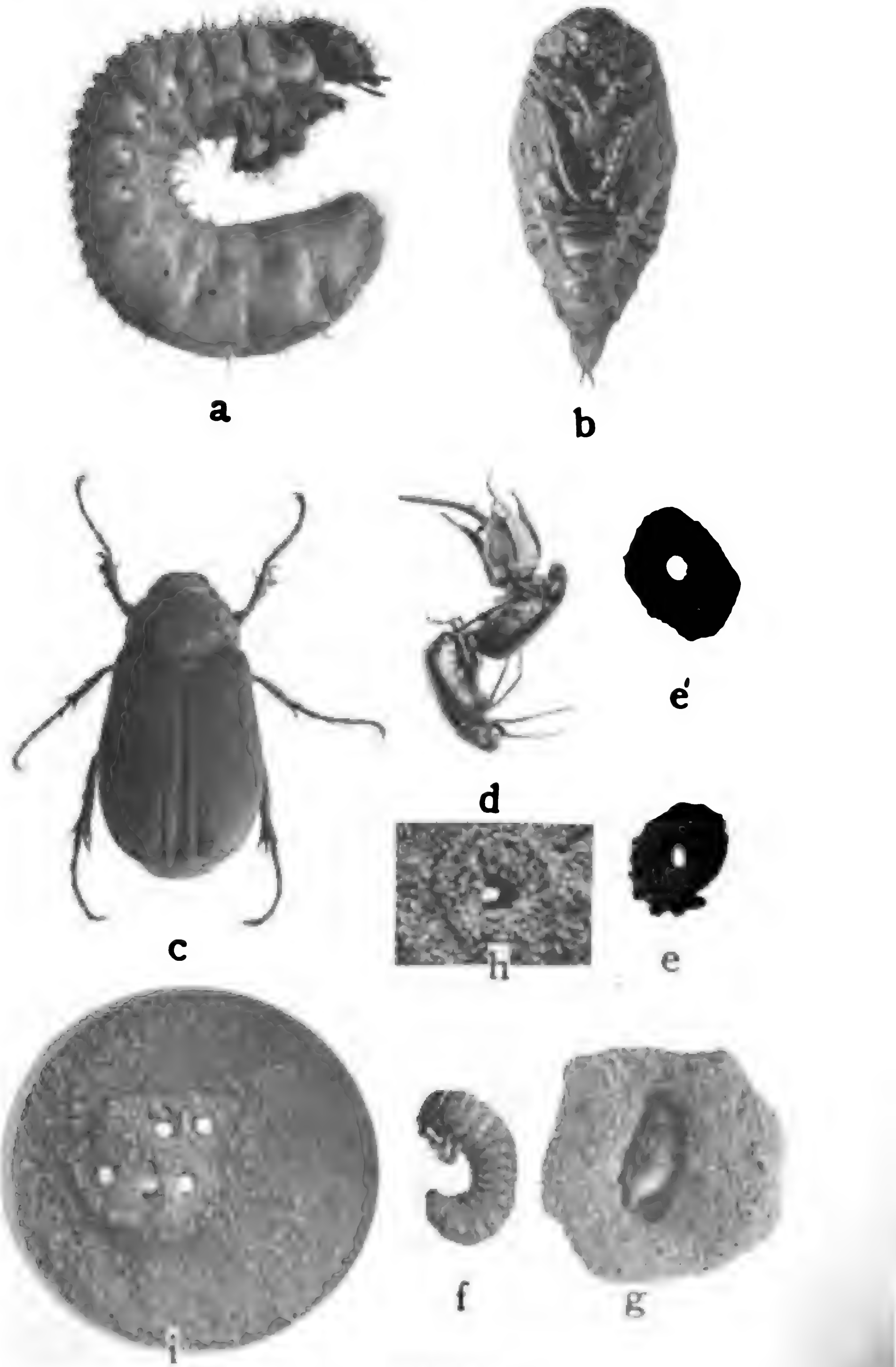
Explanation of Plate 14.

Plate 14. *a*, *Lachnosterna grandis* grub. *b*, *L. grandis* ♀ pupa. *c*, *L. prunina* ♂ adult. *d*, *L. gibbosa* in copula. *e*, *L. arcuata* egg recently laid; *é* fully swollen, *f*, *L.* sp. grub in prepupal stage. *g*, *L. gibbosa* pupa in pupal cell. *h*, *Diplotaxis* eggs, several eggs in a ball of earth in a single cavity. *i*, *Cotinis nitida* eggs, in individual cavities but many eggs in a single ball of earth; *a*, *b*, and *c* much enlarged, others about natural size.



White grubs, various stages

Corn field at Platteville, Wis., badly damaged by white grubs. Aug. 18, 1915

40-acre corn field at Froelich, Ia., destroyed by white grubs. Aug. 6, 1915

Timber patch (burr oak and hickory) at Platteville, Wis., defoliated by May-beetles. Shrubs at the base of trees and portion of boxelder tree at extreme left undefoliated. June 1, 1914.

Large cottonwood, an ash and several elm trees defoliated by May-beetles. An apple at extreme left untouched. Galena, Ill. May 13, 1914.

growth before the grubs are actively feeding the following summer, is a good crop to follow on grub-infested land. Likewise small grain crops are not greatly injured by grubs and should be used for grub-infested ground in preference to the more susceptible crops such as corn. Aside from the rotations mentioned above, it is desirable to so arrange the crops that the least amount of land will be in timothy and small grain the year the beetles are abundant, and the following year to plant corn or other susceptible crops in corn ground or ground which was kept thoroughly cultivated during the flight of the beetles the year before, and to plant small grain or clover on ground which was in these crops the previous year.

The farmer should plow land suspected of containing grubs previous to October 15 the fall following a big flight of beetles and select a crop for the following year according to the presence or absence of grubs.

MISCELLANEOUS DIRECTIONS.—The collection of the beetles by hand or by means of a trap lantern, or by spraying trees upon which they feed with an arsenical, has been employed in certain European countries and no doubt would prove of value in this country, but to be effective it is necessary that entire communities work together and adopt the measures.

Collecting the grubs behind the plow by hand, utilizing boys or cheap labor for this purpose, is of much value although similar results can be obtained by employing hogs or chickens as mentioned above.

FURTHER NOTES ON DIPRION SIMILE HARTIG

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

The writer has already called attention in the JOURNAL OF ECONOMIC ENTOMOLOGY (Vol. 8, p. 379, June, 1915), to the occurrence of this European pine sawfly in Connecticut. That article will enable one to recognize the species, and also points out the possibility that it may prove a destructive pest in this country as it is in Europe. He now wishes to add a few data collected in the further study of this insect since the former article appeared in print.

Diprion simile is present in Connecticut not only at New Haven, but also at Derby, ten miles westward, at Hartford thirty-seven miles northward, and at New Canaan, about thirty miles, and Greenwich about fory-five miles westward. Greenwich and New Canaan are border towns adjoining New York state where it may be expected that this insect will soon appear.

As this sawfly was found to be present in five rather widely separated localities in Connecticut, it was probably too late for extermina-

tion, and therefore only control measures were put into effect. These consisted of a careful inspection in summer and collecting all larvæ found; thoroughly spraying with lead arsenate all trees infested; another careful inspection in late fall and early winter to gather all cocoons from the twigs.

The insectary records were kept by my assistant, Mr. M. P. Zappe, to whom I am indebted for some of the data included in this paper.

During 1915, two complete generations were reared and a number of males of the third generation emerged late in the fall. Possibly another year we may be able to obtain three complete broods, because on account of an accident some of the first second-brood larvæ died. The broods overlap and are rather irregular. Some of the over-wintering pupæ did not produce adults until after the first generation of larvæ had matured. If the needles became dry, as is sometimes the case with cut twigs, the eggs failed to hatch. Unfertilized eggs hatched, and the larvæ developed normally to the pupal stage, in which condition they are now passing the winter.

The average length of the larval stage appears to be about thirty and one-half days.

In Connecticut *Diprion simile* feeds upon the white pine, *Pinus strobus;* the Austrian pine, *P. laricio* var. *austriaca;* the Japanese or Bhotan pine, *P. excelsa;* the Scotch pine, *P. sylvestris;* the mugho pine, *P. montana; P. flexilis* and *P. densiflora.* All newly-hatched larvæ died when fed on Austrian pine, but after the first instar they were able to finish their subsequent development upon this food plant. Probably when in need of food this sawfly may attack almost any kind of pine and possibly other conifers.

There is some consolation in learning that *Diprion simile* is highly parasitized, and of the parasites which have been reared up to this time, all are native American species; I am indebted to Mr. S. A. Rohwer of the Bureau of Entomology for their identification. Of 152 over-wintering cocoons, 46, or about 31 per cent, were parasitized by the Chalcid fly *Pachyneuron* (*Dibrachys*) *nigrocyaneus* Norton. One specimen each of *Hemiteles utilis* Norton, and a species of *Cerambycobius* were obtained. Tachinid eggs are not uncommon upon the larvæ and *Exorista petiolata* Coquillett was reared from the cocoons.

APIARY INVESTIGATIONS IN MISSOURI

By L. Haseman, *Columbia, Mo.*

In the past few years the writer has felt the growing need and demand on the part of farmers and beekeepers for help along beekeeping lines. The state agricultural colleges for years have been teaching

better agricultural methods and the experiment stations have been investigating methods of increasing yields and maintaining soil fertility while the beekeepers have received comparatively little help. At least these have been the conditions in this state. In some cases the profits from bees have helped to send young men and women to the University, where they have found instruction in almost every subject except beekeeping.

Three years ago the first real instruction in beekeeping was given by this department. Along with the development of courses in beekeeping we have begun some investigations and are planning more extensive work for the future.

In Missouri it seems that beekeeping must inevitably resolve itself into farm beekeeping. Our natural, climatic and agricultural conditions all point in the direction of small apiaries if future beekeeping in Missouri is to thrive. We do not have conditions for successfully maintaining apiaries of hundreds of colonies in any one locality. If ten strong colonies of bees will save the honey flow in any locality why try to maintain an apiary of fifty colonies to accomplish the same end and eat up all the profits? Since these conditions prevail with us, we have planned, first of all, to "preach the gospel" of small apiaries, well located, with only strong vigorous colonies of bees. Our first investigations are also planned for like conditions. Along with the preparation of our first report on "Farm Beekeeping," now in press, we have been studying economical methods of securing a few strong colonies as a start and the necessary equipment so as to place beekeeping within the reach of every family. A few strong, well cared for colonies of bees on every Missouri farm is the remote goal toward which we are working.

The simple methods of dividing and forming nuclei and the methods of queen rearing and requeening are being studied with a view of enabling any farmer to build up his apiary. We have demonstrated in a modest way in our department apiary that without the expenditure of much money, any one, who is willing to study and work, can build up a small apiary and secure both profits and pleasure from it. Our colonies are used both for class work and for demonstration purposes at fairs and yet in the past three unfavorable seasons we have built up an apiary of from two to seven excellent stands, and have gotten surplus honey every year, even as much as sixty pounds from one of the stronger stands one season. These smaller and simpler things in beekeeping are receiving our special attention now for we realize that to develop successful farm beekeeping in the state we must first reach the beekeepers with simple, practical farm methods. The larger problems of out-apiaries, wintering in cellars, engine extracting outfits and the like have no place in our present work.

We find, according to Dr. Phillips of the Bureau of Entomology of the U. S. Department of Agriculture, that next to Texas, Missouri is in the lead as regards the number of colonies of bees. In round numbers we have 40,000 farmers and others keeping bees with a total of 203,569 colonies. It is with the problems of these forty thousand beekeepers, who have on an average five colonies each, that we are now vitally concerned in order to help make, if possible, not 25 per cent but 100 per cent of the total number of colonies self-supporting and profitable.

Of all the important subjects confronting us the one which seems most vital and in need of first attention is the whole question of bee pasturage. Our honey flows are usually very short and some seasons dry weather shuts them off suddenly when they may not open again until late in the fall. These are the conditions which make beekeeping such a gamble; especially in case of large apiaries. The following questions are a few which we hope to solve within the next few years: How many colonies of bees can one profitably keep under different surroundings in this state? What are our important honey plants? What agricultural crops can we hope to use for bee pasturage? How can we make use of much of our waste lands for beekeeping? Is it possible to keep a few colonies of bees with profit in spite of unfavorable seasons as regards honey flow? Some of these questions have already been touched upon but further investigation of them is necessary. Some of these investigations will be carried on in coöperation with our more progressive and observing beekeepers while the more technical studies will be undertaken in the department apiary on the college farm at Columbia.

Rocky hillsides, unfit even for blue grass pasture, will be worked over and used for growing different plants of possible value as bee pasture. Thousands of acres of Missouri hills now lie idle, much of which may under proper treatment serve as profitable bee pasture. Along with the investigations of waste lands for bee pasture, tillable plots will be used for growing cultivated and wild plants which show promise of proving of value as bee pasture. Our principal honey crop, white clover, is too susceptible to our hot dry spells in early summer and if possible some other crop should be found to serve as a substitute for white clover under unfavorable seasons. Sweet clover or "bee clover" as some call it, has already shown promise under our conditions and it will be investigated thoroughly.

In coöperation with Missouri beekeepers and the recently incorporated Missouri Apicultural Society, the Entomological Department of the University hopes to be able to help develop and direct a more intelligent and a more profitable system of beekeeping in the state. In the future, in this state we must have more intelligent, intensive and less extensive beekeeping.

A NEW METHOD OF SUBTERRANEAN FUMIGATION

By J. S. Houser, *Wooster, Ohio*

Some years since while in the employ of the Cuban Agricultural Experiment Station, the writer started an investigation of methods for the control of the fungous-growing ant, *Atta insularis*, known locally as the bibijagua. The studies were interrupted soon after they were commenced, and were never completed, but a start was made in the development of an unused principle for subterranean fumigation which gave evidence of such promise that it has seemed worth while to place it on record.

This ant is to Cuban agriculture and horticulture what the white grub is to the northeastern quarter of the United States, *i. e.*, the most generally destructive single insect pest. In passing, it may be well to note that the nature of the injury consists in the insects stripping the foliage from plants, the mutilated leaves being taken to galleries in the soil where they are used as a media for the growing of the fungous gardens. The various species of Citrus leaves seem the preferred sorts, but, in the absence of these, a large number of other plants are used. Occasionally an entire tree is stripped of its foliage during a single night, it being the habit of this insect to confine its marauding expeditions to the late afternoon and dark hours of the night.

The herbage is piled in culture chambers located beneath the surface of the ground, the average size being that of one's two clenched hands. In newly established colonies these chambers are few in number and are located near the surface of the ground and there is little external evidence of the colonies; but in aged, well-established colonies, the ramifications sometimes extend to a depth of eight feet and a large mound of earth is thrown up above. Such colonies have a number of entrances, some directly above and some a considerable distance away, these being reached through tunnels. The mound itself is a perfect labyrinth of passageways and fungous gardens, the ants being found in all parts of it. Swarming occurs in the spring at which time the new queens in immense numbers emerge from the old colonies and establish new ones.

Three methods of control have been practiced, briefly described as follows:

(1) The digging out method.—With this process, the formicary is excavated and the ants and their fungous gardens are collected and burned. It is expensive, laborious and only moderately successful.

(2) The carbon bisulfide fumigation method.—With this, the liquid bisulfide is poured into the openings to the nest and the fumes allowed

to settle. The weakness of this method lies in the fact that the soil quickly absorbs the liquid and the fumes are liberated so slowly that a small percentage only of the efficiency of the material is realized.

(3) Fumigation with sulfur fumes.—This process involves the use of a special apparatus for generating the sulfur fumes. The fumes, generated by a fan or bellows, are introduced under pressure into the galleries of the nest. The apparatus is cumbersome and slow to operate, much time being lost in building the charcoal fires in the generator. Moreover, the fumes possess only moderate killing power, and, being lighter than air, are with difficulty forced to the utmost parts of the ant-hill. For the same reason, the fumes have a tendency to rise and escape just as soon as the pressure above is released.

The principle of the method of control, used by the writer, consisted in forcing vaporized carbon bisulfide into the ant-hill. Stated briefly, a jet of air was liberated at the bottom of a volume of carbon bisulfide contained in a closed vessel, and the air, bubbling up through the liquid, vaporized the bisulfide. The vapor was then forced through a tube out of the generator and down into the galleries of the ants.

Both laboratory and field tests were conducted, the former to determine the actual killing power of the gas and the latter to determine both the killing power and general practicability of the method under field conditions.

For the laboratory tests, the gas generator consisted of a wide-mouthed bottle with two glass tubes passing through the cork, one of which extended to the bottom of the bottle and the other just through the cork. One hundred cc. of Taylor's Fuma carbon bisulfide was poured into the bottle and air forced through the long tube. The impregnated fumes were conducted through a tube to an open-mouthed bottle into which the ants were placed. A uniform pressure of four pounds to the square inch was maintained and the air-conducting tube was just large enough in diameter to prevent the apparatus from bubbling over. A large series of tests were made, wherein lots of four or five ants were placed in the bottle for receiving the charged air and exact record taken of the time required for each ant to stop movement after the gas was introduced. The average was about thirty-three seconds for workers and a little less time for soldiers. If the ants were left in the bottles they did not revive.

When the generating cells were arranged in series of three, as was anticipated, a little less time was required for killing, since the charged air passing from cell No. 1 carried away a part of the bisulfide of No. 2, and a less amount of No. 3, thus indicating that the air after passing

through the three cells was more heavily charged with the bisulfide than after passing through one cell only.

For the field work, an iron retort was constructed having a quarter-inch gas-pipe passing through the lid to the bottom of the apparatus, and an opening near the top to which was joined a rubber hose. The other end of the hose was connected to the stem of a metal funnel, placed in an inverted position over the entrance of the ant hill and the earth banked up about the funnel's sides. About two litres of bisulfide was poured into the apparatus and air from a blacksmith's bellows forced through it. Working in fields where there were numerous, newly established colonies, thus necessitating considerable moving about, approximately two litres of bisulfide were used per day. As compared with the sulfur fumes method, it is more rapid, convenient, and, so far as the writer was able to judge, during the short time after the work was started that he remained in Cuba, the results seemed more lasting.

The field apparatus was exceedingly crude, and would admit of much improvement. An air pump instead of a bellows and a thin sheet-metal retort instead of an iron one would both lighten and simplify the machine.

Should future studies demonstrate the indicated effectiveness of the method described, its usefulness as a means of destroying the Attiine ants alone would be rather extensive, since according to Wheeler the range of distribution of this tribe is between the 40th parallels, and, should the treatment prove effective and practicable against other earth-inhabiting ants, its range would be considerably increased. Introducing the gas under pressure, the gas being heavier than air, and the cheapness of the process, are all points in its favor.

SOME WORK OF THE EXTENSION ENTOMOLOGIST IN KANSAS AND MISSOURI

By Thos. J. Talbert, *Extension Entomologist, Agricultural Extension Service, University of Missouri, Columbia, Mo.*

The chief object of the extension entomologist is to acquaint the gardener, the orchardist and the farmer with the practical facts about the habits, life-histories, injuries and control of insects. When this has been done the producer is more capable of intelligently shaping his farm practices in a way that will be unfavorable to the development of injurious insects. He is also more interested in his work, and if sprays, poison bait, or mechanical barriers are necessary to control the pests, he knows how to prepare and how to use them most effectively.

Field meetings and demonstrations are of great value to the farmers because they are able to study the insects in their different stages upon their food plants. The farmers learn in the field in a few minutes more than any amount of reading or lecture courses could teach them. They are also freer to talk and to ask questions when in the field. If their interest and attention is aroused in the field, the literature on insects and their control appeals to them and they will make a study of it with the determination of putting into practice the remedies or control measures suggested.

The apparent indifference and lack of knowledge on the part of many farmers concerning insects is due perhaps to a number of causes. Prominent among these is the small size and insignificant appearance of many injurious insects. If the pests were as large as hogs, sheep, colts or calves no doubt their habits, life-histories and control would be well understood by every farmer. The damage and ravages of insects are often attributed to floods, storms, droughts, lack of soil fertility and the like. It is also a fact that the general public knows less about insects than any other branch of agriculture. Many country school teachers are not even on speaking terms with the chinch bug, Hessian fly or army worm. A few farmers will say: "There is no use of trying to control the insects, because we have always had them with us and we always will have them. We will just have to depend upon the weather and the Lord to control them—that's all."

This indifference and lack of interest in insects is not confined entirely to farmers. Many business men, professional men, and college teachers have no notion whatever of the value of a knowledge of insects. It is a sort of a general notion among some that a discussion of insects is going to be dry and uninteresting and it is not worth while anyway. When the subject is handled properly, however, it is equally as interesting as any other phase of the extension work. In many cases farmers have been heard to say: "Well, I am not much interested in bugs, I wish we had a man here to talk live stock." When once the farmers are shown the insects and their work in the fields, they are anxious to know more about their habits, life-histories and control. They see at once that their health, happiness and prosperity may depend in no small way upon a knowledge of insects. Farmers are always immensely interested in a practical discussion on insect control.

Some Practical Demonstrations

About the middle of last June the so-called wheat head army worm (*Meliana albilinea*, Hbn.) appeared in damaging numbers in many

of the wheat fields of central Kansas. Hurry-up telegraph messages and long distance telephone calls concerning the army worms poured into the office of Professor Dean, head of the Department of Entomology, Kansas State Agricultural College.

When the extension entomologist arrived at Nickerson, Kansas, to investigate the trouble, to his surprise about thirty farmers met him at the station in automobiles. Many specimens of the worms and their work upon the wheat were shown. After a brief discussion of the pest and the measures of control at the railroad station, we were taken to a wheat field about seven or eight miles from town. Here we found about one hundred and twenty-five farmers present and after another discussion of the pest we proceeded to the wheat field. After a thorough investigation of several fields it was found that most of the worms were present along the ravines, around straw piles and places where the wheat grew the rankest.

That afternoon a meeting was held in the town hall at which more than two hundred farmers were present. A two-hour discussion of the army worm and the Hessian fly held almost every farmer in the hall during the warm afternoon. A night meeting was held in a neighboring town at which 75 farmers attended. The farmers were interested because their wheat was being completely destroyed by the worms and they could plainly see that unless something was done at once their wheat crop would be ruined.

A formal declaration of war was issued against the worms and the ammunition used consisted of the poison bran mash made according to the Kansas Agricultural College formula, 20 pounds of wheat bran, 1 pound of Paris green, 3½ gallons of water, 3 oranges or 3 lemons and 2 quarts of molasses. The poison bran mash was sown broadcast in the wheat fields during the later afternoon and at night. In most cases it was not necessary to sow the entire fields because the worms were often damaging only the rankest growing wheat. An effort was made, however, to sow the poison bran wherever the worms were numerous enough to cause any noticeable injury.

More than two hundred farmers made use of the poison bran mash on that evening and out of about half that number reporting the following morning every one said that the poison bran mash was almost 100 per cent effective. It was difficult to find a single live worm where the bran was sown. The dead worms were so thick over the surface of the ground that it was difficult to make a shoe track without crushing a half dozen or more worms. One farmer in describing the results said: "I hunted an hour in my wheat field this morning to find a live worm. In all I found one and it died while I was watching

it." The wheat was almost completely destroyed in the badly infested fields where the poison bran mash was not sown.

Hessian Fly Campaign in Missouri

Every section of Missouri was covered in the campaign against the fly during August and September. More than sixty meetings were held and about three thousand farmers studied the fly and learned more about its habits and the methods of controlling it. The insect was studied at first hand in its different stages in the fields and valuable information and data was obtained.

At the beginning the idea was to acquaint the wheat-growers with the habits, adaptations and characteristics of the insect, believing that such a knowledge would help them combat the pest. With this in mind many meetings were held in the old wheat fields where it was usually possible to study the Hessian fly in the egg, maggot, flaxseed and adult stages. Here in a few minutes the farmers were able to learn more about the fly than any amount of reading or lecturing could possibly teach them.

During every field meeting the farmers seemed freer to ask questions and a great deal more interest was manifested than is usually the case in the schoolhouse or lecture room. It was said many times by wheat-growers that they had learned more about insects during the 20 or 30 minutes spent in the wheat field than they ever knew before.

Many meetings were held in the fields where the farmers were threshing wheat, filling the silo or making hay. In some cases the Hessian fly was discussed with individuals or with groups of four or five until all the farmers present had been reached, while at other times all the farmers were addressed at the noon hour. In this way the meetings did not interfere with their work. By means of samples of old wheat stubble and volunteer wheat the discussions were made as practical as possible.

Rural schools and high schools were visited. The pupils were taught by means of charts and field specimens the life history of the Hessian fly, its habits and the best methods of controlling it. After the meetings it was common to hear the farmers say: "Well, if I had known as much about the fly last year as I do now it would have saved me several hundred dollars."

The writer was employed last year by the Kansas State Agricultural College as Extension Entomologist and on the first of August, 1915, he accepted a similar position with the Missouri College of Agriculture.

AN INVESTIGATION OF THE SUPPOSED IMMUNITY OF SOME VARIETIES OF WHEAT TO THE ATTACK OF HESSIAN FLY

By L. HASEMAN, *Columbia, Mo.*

It is a well-known fact that some varieties of trees and other plants possess a greater or less degree of immunity to certain diseases and insect pests, while other similar varieties or strains are very susceptible to them. This is true not only of the plants themselves but also of some fruits and seeds. Among practical farmers and grain breeders there is a general impression that some strains of wheat are less affected by smut, rust and Hessian fly. If this is the case, other things being equal, that strain which has tendencies toward immunity would seem to be the one to grow. However, there are many other factors which must be considered.

The variety of wheat which is most susceptible to fly attack may possibly be more hardy, and more given to stooling and in this way it may perhaps yield more grain than other varieties less severely attacked by the fly. In other words one variety may be able to furnish food for a large crop of flies and yet yield more grain than a second less susceptible variety. Since the farmer is after yields, he wants to grow that variety which for his locality, gives the greatest yield. The Hessian fly, while a most destructive pest of wheat, can, with proper farm practices, be kept entirely under control. Under such conditions the use of resistant strains proves of but little value. However, where less careful systems of farming are in force, great good would come from the development and use of a heavy yielding, resistant strain of wheat.

For the past few years the Hessian fly has been unusually abundant in the Mississippi Valley and in spite of all that we have been able to do in this state the annual loss from the fly has been severe. This inability to secure the needed coöperation of all farmers in some sections for controlling the fly through practical farm practices has led us to undertake this investigation. If we can find among our standard or new varieties of wheat one or more which will stand up better under fly attack, and give even only a small percentage more yield the work will not have been in vain.

The investigation has been under way for only one season and comparatively little real valuable data has been gotten. Our plan first of all is to determine whether or not the fly really breeds more abundantly in some varieties than in others. If it does we have at

least something definite to work on. On the other hand, if the fly is found to breed in equal numbers in the different varieties there is still the possibility that some of the varieties will be able to resist the effects of the fly better than others.

Studies are being made to determine whether or not physiological differences in plants of the different varieties, chemical composition of the sap, ash content and other factors associated with the plant itself, tend to make plants of one variety more attractive to the fly. Such factors as stooling, hardiness of plants and strength of stalk, which may tend to help the plant resist the work of the pest, are also being investigated. In the end the subject of yield must be considered. Much valuable data on comparative yields of the standard varieties, in different sections of the state both for fly-years and fly-free years are available from the records of the Department of Farm Crops, but additional records will be secured from carefully laid out plots where the factor of fly injury alone will be considered.

Result of First Year's Work.—In the first year's work only three varieties of wheat were used: Fultz, Fulcaster and a supposed fly-immune variety developed by a farmer. The plots were sown side by side the 24th of October, 1914. The soil was rich and had stood idle the previous summer. The plot was a quarter of a mile from the nearest wheat and a mile from badly infested wheat. The late date of sowing, together with the distance from infested wheat, prevented the fly from appearing in it in the fall. In order to make sure that some fly would be present in it in the spring, infested volunteer wheat was collected and evenly distributed in small piles about the plots on April 10, 1915. Two days later flies were found on the wheat and the plots became severely infested.

On May 1, maggots were found to be abundant in all three of the plots and on May 3 the first flax-seed stages were found. On May 10, samples of wheat were collected at random from the three plots and counts made to determine the number of larvæ and "flaxseeds" present. From these counts the following data was secured:

Variety	Per Cent of Stools Infested	Greatest Number in a Single Stool	Average Number per Stool
Fultz................	58	18	2.72
Fulcaster............	66	8	1.46
Check..............	54	12	1.7

In Fulcaster the infestation was more general, though decidedly lighter than in the other two varieties. Fultz was decidedly the most heavily infested which agrees with the observations of practical farmers. The check or supposed immune variety was slightly more heavily infested than Fulcaster.

A second set of samples were collected on June 18, which gave the following data:

Variety	No. of Stools	Maggots	Flax-seeds	Parasit-ized	Emerged
Fultz	100	92	69	12	3
Fulcaster	100	11	23	4	6
Check	100	0	21	0	3

Here again Fultz showed a decidedly heavier yield of maggots and "flaxseeds" while the check variety showed fewer than Fulcaster. In all three of the varieties there was a smaller total number of maggots and "flaxseeds" than on May 10. Some had emerged to form a partial second spring brood and the wheat was all badly lodged which with the excessive rainfall made it difficult to collect all the "flaxseeds" when the samples were gathered.

From this data it seems unquestionable that some varieties become more severely attacked by the fly than do other varieties. Fulcaster shows decided tendencies toward immunity as compared with Fultz in this test at least. This data also show that a supposed highly immune variety may in reality be as badly attacked as some of our standard varieties.

In connection with the studies on the stooling properties of the three varieties under consideration, counts were made on June 26. From these counts the following data were secured:

Variety	Average Number of Stools per Plant
Fultz	4.39
Fulcaster	3.71
Check	3.67

In this particular experiment Fultz which was the most severely infested showed a slight increase of stools, though not enough to counter-balance the greater supply of flies which it was called on to feed.

Lodging.—Observations on the tendencies of the three varieties to lodge showed that there was little difference between Fultz and Fulcaster but the check variety practically all lodged. In all of the varieties lodging was very severe as would naturally be expected from the extent of infestations.

Ash Content of Plants and Straw.—Determinations of the ash content of the different varieties have been made to see if it varies materially in the three varieties and also if it perhaps may be a factor in attracting or repelling the fly. Analyses have been made of young wheat plants taken when the fall brood of maggots were at work; also of the mature straw. These analyses do not show any very material

difference but may prove to be of interest. Further studies are to be made along this line. The analyses gave the following data:

Variety	Per cent Ash in Young Plants	Per cent Ash in Straw
Fultz	15.146	5.147
Fulcaster	15.379	4.598
Check	14.796	4.751

The extent of infestation in the three varieties seems to vary directly with the ash content.

YIELD.—Our records on yield for the first year's work are unsatisfactory though they give some light on the comparative yields of the three varieties under investigation. A plague of English sparrows interfered with the data on total yields. Representative heads were collected on June 26 and weighed.

Variety	No. of Heads	Weight	Weight per 100 Heads
Fulcaster	371	334 grams	90.03 grams
Fultz	439	324 grams	73.80 grams
Check	367	273 grams	74.38 grams

Fulcaster far outweighed both the other varieties. It is a bearded variety, however, which perhaps accounts for part of the extra weight. These heads were not threshed since the main crop was lost.

PHYSIOLOGICAL STUDIES OF PLANTS.—In connection with investigations by the Department of Botany on the smuts and rusts of wheat, observations are being made with a view of detecting any structural difference in the plant of the standard varieties of wheat. These data will also be of value in connection with this work and will be available later.

PLANS FOR SECOND YEAR'S WORK.—This work is being continued and this year the following varieties are being used on a larger scale: Harvest King, Beechwood Hybrid, Check mixed, Mediterranean, Deitz, Turkey, Check pure, Fulcaster, Fultz, Michigan Amber and Pool. Sowings have been made early and late to determine what effect it has on the fly and on the wheat itself as regards winter injury. The investigation this year will also include data on these varieties in the experimental fields of the Department of Farm Crops both here at Columbia and at the substations over the state. This it is hoped will enable us to present more really valuable data on this subject another year.

CONCLUSION.—From the first year the only important conclusion that has been reached, is that some varieties of wheat are more severely attacked by the fly than others. The data at hand is insufficient for definite conclusions regarding the other subjects under investigation.

THE SMALL PINK CORN WORM (BATRACHEDRA RILEYI WALS.) IN MISSISSIPPI

By R. W. HARNED, *Agricultural College, Mississippi*

During the past fourteen months the small pink corn worm, *Batrachedra rileyi* Wals., has attracted more attention than any other insect pest occurring in Mississippi. During the nine years that the writer has been in the state, he has observed these small pink larvæ on several occasions feeding in injured cotton bolls, in old corn cobs, and in corn that had previously been damaged by other insects. During November and December 1914 the writer received hundreds of complaints in regard to the work of this insect in stored corn. Letters came every day, telephone calls for help were many, and the extension workers of the college stated that at many farmers' meetings the principal topic of discussion among the farmers was the so-called "new pink worm" or "pink weevil" of corn. It may be of interest to note that most of the correspondents who sent these insects to us were from the central part of the state. Attala county contains the geographical center of the state. Over 75 per cent of the complaints in 1914 came from Attala and four counties adjoining it. Although these insects occurred in all parts of the state it was only in these central counties that they were numerous enough to do very serious damage. However, a year later or during the past three months (October to December 1915), dozens of complaints have been received in regard to these insects damaging corn from over forty different counties. The accompanying maps show the localities from which the worms were received with records of their damage to corn in 1914 and in 1915. Briefly the situation is this: In the fall of 1914 the worms caused very serious loss to corn over a limited area in central Mississippi but were to be found in corn in all parts of the state; in the fall of 1915 their damage was greatly reduced in central Mississippi but increased considerably in other sections of the state although in no section did they cause as much loss as in the central counties in 1914.

There is no doubt in the writer's mind but that the damage caused by the pink worms has often been greatly exaggerated but his own observations have convinced him that this species has done more damage to corn during October, November, and December of both 1914 and 1915 than all other insects combined. A few quotations from correspondents' letters will show how some of the farmers have regarded this insect:

Fig. 13.—Map of Mississippi localities from which *Batrachedra rileyi* was received in 1914.

Fig. 14.—Map of Mississippi showing localities from which *Batrachedra rileyi* was received in 1915.

"We are in the midst of a bad fix in our neighborhood. There is a small pink worm eating the corn. It appears in the end of the ear and eats back as it goes. It does not take long to ruin the ear."

"We have discovered a small red worm that is destroying the corn. They begin in the grain next to the cob and eat the kernel up."

"They enter the grain at the little end next to the cob and eat the grain up. Some farmers report that cribs of corn have been destroyed. Investigations show that they are in all cribs of corn. . . ."

"They appear to be worse in damaged corn but are found in sound corn."

"I find a small pink worm in nearly every grain. They seem to work from tip to butt."

". . . is eating up the corn in this section after it has been harvested and put into the crib."

"Practically all the corn in this section is infested more or less."

"They have eaten some of the corn entirely up. They are very common throughout this county."

". . . is eating everybodies' corn in this country."

"Every crib in this community is infested."

". . . is eating up the corn here after it is cribbed. They are in all the cribs here. One man told me he had 500 bushels and would take $5.00 for it."

"In the fifty years I have been farming I have never (before) found these worms in corn. They are general throughout this section."

Although the small pink corn worm has apparently never before attracted as much attention as it has recently in Mississippi it has probably long been a pest of minor importance but usually mistaken for some other insect. Walsingham [1] described this species in 1882 from specimens "bred from rotten cotton-bolls." Chittenden [2] gives us the first record of it as a corn insect. In 1897 he reared moths from larvæ both in cotton-bolls and in corn from the field sent from Texas by Mr. E. A. Schwarz. Chittenden also brings out the fact that this is the insect mentioned by Townend Glover in 1855, 1856, and 1877 as occurring in the corn fields of the South and as attacking corn in the husk. He gives it the name of "Glover's grain moth" and quotes Glover as stating "that the larvæ 'appear to attack corn out of the field as well as in,' and that the insect lives in injured cotton bolls." In 1909 Swezey [3] shows that in Hawaii they have quite general feeding habits. Among other things he says: "Once I found them very numerous in sweet corn ears, feeding on the silks, inner husks, pith, and other parts of the cob. I have also seen them in ears of field corn, eating into the kernels of corn and into the cob." In 1911 Tucker [4] records these larvæ as feeding in old corn stalks in Louisiana, especially rotting, rain-soaked stalks. He also frequently found this

[1] Trans. Am. Ent. Soc., X, p. 198.

[2] Bul. 8 n. s., Div. of Ent., U. S. D. A., p. 33.

[3] Hawaiian Sugar Planters Sta., Div. Ent. Bul. 6.

[4] Canadian Entomologist, XLIII, p. 28.

species in green corn stalks and in ear tips where they were associated with or followed other insects.

Only a brief summary of some of our observations can be given at this time: 1. The worms were found in every corn field observed during the autumn months of 1914 and 1915. 2. The number of ears infested with this species in the different fields examined varied from 10 per cent to 99 per cent. 3. The worms appeared to be more numerous in corn grown on hill lands than on bottom lands. Even in fields containing both hill and bottom land, the worms were more numerous in the corn growing on the high land. (This is probably due to the better condition of the corn from the bottom lands.) 4. In general early maturing corn contained fewer worms than late corn. 5. Although the worms appeared most numerous in the stored corn during November and December, a few were present as late as April 1. 6. These worms are most numerous in ears of corn that have been damaged by the corn-ear worm, or by other insects, and in imperfect ears; but many perfect ears that showed no sign of other injury were found to contain a few of these worms. 7. The tips of the ears are most likely to be infested but the worms may be found at any part of the ears or in the cobs. 8. The number of worms was apparently greatly reduced by the cold weather of January 1915 when the temperature dropped below 10 degrees F. on several nights. 9. During the fall of 1915 large numbers of dead larvæ have been found. The cause of their dying has not been determined definitely. 10. The worms eat the corn grains by finishing grains that have been partially devoured by other insects, especially near the tips of the ears; by entering them from the cob and leaving only an outer shell; by tunnelling through several grains in a row; by eating the tips next to the cob of several grains in a row; by eating the outer parts of several grains in a row just beneath the husks; by feeding between the rows and eating parts of the grains of two rows. 11. Sorghum and Kafir corn heads on the college farm were badly infested with the worms in July and August 1915. Specimens in Kafir corn heads from Quitman, Mississippi, sent to Washington were determined as this species by Dr. F. H. Chittenden. 12. The worms have been counted from several hundred ears. In December 1915, Mr. G. F. Arnold carefully counted the worms in 74 ears taken at random. He found an average of 4 $^{8}/_{37}$ worms to the ear. Twenty-four of these ears contained no worms. The worst infestation was in a small ear of poor corn that contained 50 pink worms, 2 in grains of corn, 27 between grains, and 21 in the cob. The next worst ear contained 41 worms, 13 in as many grains, 20 between grains, and 8 in the cob.

COÖPERATION IN THE ESTABLISHMENT OF STATE QUARANTINES

By J. Edward Taylor, *State Horticultural Inspector, Salt Lake City, Utah*

As the establishment and enforcement of quarantines is included in most crop pest laws, some observations in connection with their operation should be of interest to the members of this association although the necessity for state quarantines was very much lessened by the creation of the Federal Horticultural Board and it is to this source that we must look for maximum protection from introduced crop pests. From personal experience it would seem that our first duty is to get the Federal Board to take action. If this fails, state quarantines should be established under the most urgent conditions and should include such commodities as a reasonable effort will allow us to effectively control.

In our ever expanding and complicated commercial system, state lines are being rapidly erased. A single state is too small a unit to prevent traffic in staple commodities. The facilities at the disposal of most state quarantine officers are entirely inadequate when matched against commercial interests affected by quarantine measures. It is, therefore, important that the various states which are threatened by invasion of insect pests or plant diseases get together and close up the avenues of invasion as tightly as possible—a task which one state can hardly accomplish. Too many of our state quarantines are a delusion and a serious reflection on the general principle of pest dispersion.

The quarantines established against the state of Utah by the states of Arizona, California, Idaho,[1] Montana and Oregon on account of the alfalfa weevil which infests this state have given the writer an opportunity of observing the practical operation and effectiveness of state quarantines. In the light of scientific investigations which have been made, relative to the spread of the alfalfa weevil, not one of these quarantines, as a whole, is justified, and no state is getting protection from the alfalfa weevil by their establishment. We have had the weevil in Utah for approximately twelve years and although the infested area is being extended gradually by the insects flying and crawling, there is not a single instance where a colony of weevils has become established at any distance from the previously infested points. If ordinary commercial traffic had been a factor in extending infesta-

[1] In fairness to the state of Idaho it should be said that their quarantine was forced upon them by the authorities of California who made this one of the conditions upon which part of Idaho was released from the general quarantine which originally included both Idaho and Utah.

tion there would have been out-breaks at points considerably beyond the infested area. The introduction in Utah, presumably from Europe, is the only known case where such transportation occurred, and we do not know how this happened.

A careful investigation made by the U. S. Bureau of Entomology, in coöperation with the authorities of Utah, of the possibilities of alfalfa weevil being carried in commercial shipments, especially of alfalfa seed, nursery stock, fruits and vegetables, has been made, covering a period of three years. These investigations show that the only danger of spreading alfalfa weevil is by shipping alfalfa hay or any produce which has been handled in contact with it between the 15th of July and the beginning of winter and there is no case on record where such transportation of the weevil has occurred. Early potatoes are practically the only crop that presents any danger from this source, and it is an easy matter to handle this crop in such a way as to eliminate all risk.

The alfalfa weevil being a comparatively new pest as far as America is concerned, it is not surprising that states, establishing embargoes in the beginning, acted largely on fear and supposition and consequently established quarantines which are irrational and more or less arbitrary. Such quarantines as have already been established show a lack of coöperation between states as is indicated by the following digest of existing embargoes:

NURSERY STOCK:

Arizona—Entrance prohibited.

California—Nursery stock must be packed in fresh shavings, excelsior or other suitable packing (except tule, hay, and straw), and containers and cars must be fumigated with potassium cyanide, both at point of origin and delivery. Must be consigned to a quarantine officer designated by State Commissioner of Horticulture, who will fumigate as for alfalfa seed.

Idaho—Same instructions in packing as California, except tule hay can be used if fumigated and accompanied by an official certificate of fumigation.

Montana—Prohibited unless accompanied by an official certificate of fumigation.

Oregon—Hay, straw, tule, grass and forage plants must not be used in packing any nursery stock shipped into Oregon.

FRUITS AND VEGETABLES:

Arizona—Entrance of fruit prohibited. No restriction on vegetables.

Montana—Entrance prohibited from April to October inclusive (excepting that after August 1, fruits and vegetables may be shipped from points where inspection service is maintained by State Horticultural Inspector of Utah, all shipments to be handled under special arrangement and to bear an official certificate of inspection).

(No restriction in other states.)

ALFALFA SEED:

Arizona—Entrance prohibited.

California—Seed must be enclosed in weevil tight containers seamless (sacks) consigned to a quarantine officer, at a place designated by the State Commissioner of Horticulture of California, for disinfection at cost of consignee or owner. After disinfection seed will be released upon payment of charges.
Idaho—Same as California.
Montana—Must be fumigated at point of shipment and be accompanied by an official certificate.
Oregon—Entrance prohibited.

HAY, ALL KINDS:

Entrance prohibited (all states).

STRAW:

Arizona—Entrance prohibited.
California—Entrance prohibited.
Idaho—Entrance prohibited.
Montana—(Excludes only forage crops).
Oregon—Entrance prohibited.

BEES IN HIVE:

Arizona—No restrictions.
California—Entrance prohibited.
Idaho—Entrance prohibited.
Montana—No restriction.
Oregon—Must not be packed in hay, straw, tule, weeds or forage crops.

HOUSEHOLD GOODS:

Arizona—Must be inspected and accompanied by an official certificate of inspection made under oath.
(No restrictions in other states.)

LIVESTOCK:

Arizona—Special arrangements must be made with the Arizona State Entomologist before shipments are made, and in any case must be transferred to clean cars before crossing the state line.
California—Hay and straw must not be used in cattle cars.
Idaho—Same as California.
Montana—No restrictions.
Oregon—Hay, straw, grass and forage crops of all kinds must not be used in cattle cars.

GRAIN:

Arizona—Entrance prohibited.
(No restrictions in other states.)

It will be noted that some serious items of commerce are included in the embargoes. Utah produces a surplus of nursery stock, fruits, vegetables, alfalfa seed and live stock which is marketed in surrounding states and well established lines of commercial traffic in some of the commodities were suddenly stopped with consequent serious financial loss and disturbance to the business interests of both states.

The quarantine on fruits and vegetables going into the state of Montana furnishes the best illustration of some of the evil effects of

the quarantine system. The points principally affected are from Ogden north to the Utah state line where much of the planting for the last twenty-five years has been made with the idea of supplying the Montana market. The production of berries and bush fruits, which of necessity must go into nearby markets, is large throughout this section. The matter of readjusting the market for the fruit, etc., which had otherwise gone into Montana has caused a demoralization in the remaining local markets and a consequent serious financial loss. The competition of the Utah fruit in the Montana markets was from Oregon and Washington, but with the establishment of the quarantine, fruits and vegetables from Utah were shut out, and although the quarantine has since been modified, the Montana market has been lost to the growers of this state with no gain to Montana in the way of protection from the alfalfa weevil.

Another very serious injustice has been done to the state of Utah by including alfalfa seed in quarantine measures. When we refer to alfalfa weevil, the average layman and seedsman immediately associate it with a large group of weevils which infest seed of all kinds and figure naturally that it is a seed weevil. As a matter of fact it has nothing whatever to do with alfalfa seed and is never in any way associated with it and yet it has been the cause of a very vital prejudice against Utah seed in certain markets.

Under-ground routes have been established to a limited extent so that the object of the quarantine was defeated. The quarantine of Utah alfalfa seed had the effect of cutting the price of Utah seed in one of the states from thirteen cents to eight cents per pound, while the price of seed from the surrounding states, of course, was not affected. The result was that Utah seed immediately lost its identity as a Utah product and was shipped by way of other states into states having quarantines at the full market price. If the transportation of quarantined articles had presented any danger, the evil was far greater by the under-ground route than if the goods had gone through the usual lines of traffic where they could be protected by an inspection system. Experience with these quarantines shows above all things that where there is no coöperation between states none of them gets the protection which the quarantine anticipates.

The establishment of irrational and arbitrary quarantines, especially where they affect important items of commerce, is apt to lead to retaliatory measures being adopted by commercial interests which are affected and increases the danger of spreading the pest by incendiary measures through districts which seek by means of their quarantines to keep it out. There are some cases on record where incendiary methods have been adopted by commercial interests for their own

gain and this should be seriously considered where quarantine measures are framed. From a practical standpoint the writer does not hesitate to say that if state quarantines are to be effective, the closest coöperation between affected states must be established, and their effect on well established lines of commerce be seriously considered before they are promulgated.

CONTROL OF THE VARIEGATED CUTWORM IN VENTURA COUNTY, CALIFORNIA[1]

By G. E. Bensel, *Collaborator, Truck Crop and Stored Product Insect Investigations, U. S. Dept. of Agriculture*

Recent Injury

The variegated cutworm (*Peridroma margaritosa* (*saucia*) Hübn.) is widely distributed in Ventura County, California, and has done considerable damage in the last year (1914) to the sugar beet crop. The first serious outbreak occurred in April, 1913, when about three hundred acres of young beets were cut off just beneath the surface of the ground. These dark brown "worms" were observed concealing themselves an inch or two underground during the day time, where in a dormant stage near the attacked plants they were ready to emerge on the return of night. It was also noticed that they generally followed the rows of beets, that very few fed during the day and that most of the damage was done during the night and early morning. The depredation is completed in so short a time that only preventive remedies could be recommended. The entire field was destroyed in less than four days. This field was summer-fallowed the previous year and the last generation evidently had deposited their eggs on the volunteer vegetation and this outbreak was the result of overwintering larvæ. This field was replanted but the cutworms destroyed the stand. It was then decided to postpone the second replanting with the object in mind that possibly the cutworms would, in the meantime, mature, enter the earth, and pupate. This supposition proved true and the third stand was unmolested. Unfortunately a second serious outbreak occurred in the same field about six weeks later. This time large beets were attacked and completely stripped. Only the stems were left untouched; even the roots were considerably damaged. The cutworms eat more ravenously during cool and foggy weather; hot sunshine checks to a large extent their ravages. The yield of the affected field was considerably reduced and very likely the sugar content of the beet was also materially reduced, as the elaboration of the sugar occurs in the leaves, which were largely damaged.

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[1] Published by permission of the Secretary, U. S. Dept. of Agriculture.

Natural Enemies

Among natural enemies observed were two species of *Calosoma* *semilaeve* Lec. and *cancellatum* Esch. which contributed to the destruction of this cutworm. Although predaceous insects and parasites—among which the Ichneumonidæ must be mentioned[1]—destroy annually a great number of cutworms, practical remedies must be found to help these natural enemies in the control of this pest.

Methods of Control

In some cases rolling a young stand of beets has been very successful, in other cases no benefit was derived from this operation. If the stand of beets is completely destroyed or not worth saving, the cheapest and best way is to replant the crop, but at least three to four weeks must elapse between the two plantings. Local conditions must, naturally, be taken into consideration. In the season of 1914 no damage by cutworms to young beets was reported. April 20 was the date of the first outbreak on beets. These already had large foliage upon which spraying with arsenicals was tested.

Control by Gasoline Power-Sprayer

A gasoline power sprayer provided with a fifty-gallon barrel and one horsepower gasoline engine capable of maintaining while spraying a pressure of about one hundred and twenty pounds was used. This outfit was mounted on a light wagon with adjustable axles in order to circulate between sixteen and eighteen-inch rows of beets. Two men were required to handle the spraying outfit; one to drive and the other to attend the pump, watch the nozzles and prepare the mixture. The poison was applied at the rate of two pounds of Paris green to fifty gallons of water with the addition of one pound of molasses in order to render the solution more adhesive. Two or even three applications were required to check the work of the cutworms and these applications were made at an interval of four days. After the second application, the voracity of the cutworms decreased considerably. This device covered four rows of beets and sprayed about ten acres of beets in a day at the following cost:

Depreciation of apparatus	$0.35
Gasoline	0.25
Ten lbs. Paris green	2.00
Two horses and two men	6.50
	$9.10

This is approximately $0.90 per acre for each application.

[1] One of the species reared is *Enicospilus purgatus* Say.

Control by Dry Paris Green

The dry application of Paris green by means of a special arrangement on the ordinary horse cultivator was also tested. This method apparently gives a more uneven distribution of the Paris green but has the advantage of giving an extra cultivation to the suffering beets which undoubtedly stimulates their growth and thus increases the resistance of the weakened plants. The dry application was made early in the morning while the leaves were still damp in order to cause the poison to adhere better to the foliage. The tops of the sprayed beets were fed to cattle during the summer and no bad effects were reported.

Ditching

The writer also recommends that around the adjoining fields a ditch about one and one-half feet deep should be plowed as the cutworms are known, under certain conditions, to acquire the marching habit although this has never occurred so far in this locality. The ditch should be constructed with steep sides so that the cutworms cannot climb out and are obliged to travel along the bottom of the ditch and gather in holes placed along the bottom about forty feet apart.

Trapping Moths by Lights

Besides the above-mentioned remedies another preventive remedy was tried which has been used on a large scale in Germany and Russia—the trapping of the adults or moths by means of light traps. In the various infested districts eight large electric arc lamps of 3,000 candle power each were installed, burning four kilowatt-hours a night of nine hours at a cost of approximately thirty cents a night. In the districts where no electric current was available a Milburn portable 500 C. P. acetylene gas light consuming about ten pounds calcium carbide at five cents a pound, or fifty cents a night, was used. Underneath these lights and at a distance of about ten inches a shallow galvanized iron pan four feet in diameter is set on a wood platform six feet above the ground. This pan contains water covered with a light coat of oil. The moths captured were counted every morning and a total of 96,046 moths were captured by the Arnold Dump trap light. All the electric light traps were placed upon the platforms of the sugar-beet unloading dumps which are about twelve feet above the ground. The 96,046 moths were caught during thirty-six nights at a cost of $17.28 (144 kilowatt hours at twelve cents) or approximately at a cost of twenty cents a thousand. The number of moths captured varies greatly with the weather conditions at night. An essential condition for success is that the night should be warm, quiet and dark. During

periods of drought or fogs the moths are difficult to capture. Besides the eight large lights, twenty-four small light traps were installed by individual farmers. These small lights captured about one thousand moths during a favorable night. The total number of moths captured reached the phenomenal figure of 1,000,000 during the season of 1914 at a cost not exceeding twenty-five cents a thousand.

Many entomologists consider this method impractical, claiming that the females are captured after having deposited their eggs and that oviposition occurs immediately after the issuance of the moth. There is no doubt that the traps yield more males than females and that a large portion of females have already oviposited but the writer does not believe that the eggs are deposited immediately after the emergence. Copulation usually takes place very shortly after the appearance of the moths and the writer believes that several days may elapse after the moths appear before all of the eggs are laid. Mr. J. E. Graf, of the Bureau of Entomology, examined last year many captured moths and found that about 22 per cent were gravid females.

To sum up, the writer's experience shows that the treatment herein mentioned is worth the slight expense and although it cannot entirely control the cutworm plague it has extensively contributed to that end.

PARASITISM AMONG THE LARVÆ OF THE MEDITERRANEAN FRUIT-FLY (C. CAPITATA) IN HAWAII DURING 1915

By E. A. Back and C. E. Pemberton, *Bureau of Entomology*

Entomologists interested in the control of insect pests by natural agencies are already aware of the most excellent results obtained in the Hawaiian Islands from the introduction of parasites of the sugar cane leaf hopper (*Perkinsiella saccharicida*) and of the sugar cane borer (*Rhabdocnemis obscurus*). They will therefore follow with unusual interest the progress made by the parasites of the Mediterranean fruit-fly (*Ceratitis capitata*) introduced by Messrs. F. Silvestri, D. T. Fullaway and J. C. Bridwell from Africa and Australia under the auspices of the Hawaiian Board of Agriculture and Forestry.

The Mediterranean fruit-fly, since its introduction at Honolulu from Australia about 1910, has spread to all the important islands of the Hawaiian group, and, because of the great variety of its host fruits, an equitable climate, and peculiar physical conditions of the country, has not only seriously checked the horticultural development of the Islands, but has succeeded in withstanding all attempts directed at its control by artificial measures.

Sprayer used in sugar beet fields for variegated cutworm at Oxnard, Calif. (Original)

Sprayer used in sugar beet fields for variegated cutworm at Oxnard, Calif. (Original)

Acetylene gas globe and trough for capturing cutworm moths at Oxnard, Calif. (Original)

While the export trade of the Islands in fruits except the banana and pineapple has been destroyed by the horticultural quarantines following the advent of this pest, it is hoped that the introduced parasites may be sufficiently effective to make possible the growing for home consumption of certain fruits now always badly infested.

Having undertaken an investigation of the Mediterranean fruit-fly in Hawaii for the Bureau of Entomology in 1912, the writers have had an excellent opportunity to follow the progress of parasitism of this pest. Their work during 1912 and 1913 makes it absolutely certain that no parasitism existed among the eggs, larvæ or pupæ up to the time when Dr. Silvestri arrived with his parasites. In their paper entitled "Parasitism among the Larvæ of the Mediterranean Fruit-fly (*C. capitata*) in Hawaii during 1914," published in the Report of the Hawaiian Board of Agriculture and Forestry for the biennial period ending December 31, 1914, the writers gave a large number of percentages of parasitism obtained during their biological work. The present paper records similar data obtained during the year 1915.

As shown by the reports of the Hawaiian Board of Agriculture and Forestry, the South African *Opius humilis* and the Australian *Diachasma tryoni* were introduced by Dr. Silvestri as a result of the first parasite expedition to West Africa, while *Tetrastichus giffardi* and *Diachasma fullawayi* are the results of the Fullaway-Bridwell Expedition to West Africa. For a full account of these expeditions see the Report for the year 1913–1914, and Bulletin No. 3 of the Hawaiian Board of Agriculture and Forestry.

For the information of the reader it should be stated that a few specimens of *O. humilis* and *D. tryoni* were liberated in the Kona coffee district on June 13, 1913, but in Honolulu neither parasite was liberated until December 1913, when colonies of *O. humilis* were liberated. No *D. tryoni* were liberated in Honolulu until early in 1915. Between October 27 and December 31, 1914, Mr. D. T. Fullaway reports having liberated 14,450 specimens of *T. giffardi* on the Island of Oahu and 2,800 in the Kona and Hilo districts of the Island of Hawaii. Of *D. fullawayi* during the same period but thirty-five specimens were liberated on the windward side of the Island of Oahu, and 195 specimens in the Kona district, Island of Hawaii. Although many more liberations were made during 1915, it is evident that the percentages of parasitism of *D. fullawayi* and *T. giffardi* recorded in Tables I, II and III represent the establishment and control exerted by these parasites during the first year after their liberation, both in Honolulu, and in the Kona district of the Island of Hawaii; while those of *O. humilis* and *D. tryoni* represent the control exerted by these two parasites during their second year after establishment in the

Kona district of Hawaii, but in Honolulu during the second year of *O. humilis* and the first year of *D. tryoni*.

The data in Table I are interesting for several reasons. Although large numbers of *T. giffardi* have been liberated in the Kona district, no specimens of this parasite were bred from larvæ developing in the coffee cherries. All infested coffee cherries were picked from the tree

TABLE I. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN COFFEE CHERRIES (*Coffea arabica*). GROWING IN KONA DISTRICT, HAWAII

Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism				
			Opius humilis	Diachasma		Tetrastichus giffardi	Total
				tryoni	full-awayi		
Kainaliu[1]	1/15-16	126	97.6	0.8	0.8	—	99.2
"	1/16-18	123	92.7	0.8	—	—	93.5
Kainaliu	2/2 - 3	29	65.5	3.4	—	—	68.9
"	2/3 - 8	147	59.1	1.3	—	—	60.4
Kainalui	2/6 - 8	54	85.3	9.3	—	—	94.6
"	2/8 -10	86	86.0	1.2	—	—	87.2
Kainaliu	3/15-18	60	92.0	—	—	—	92.0
"	3/18-19	81	85.1	—	—	—	85.1
Kainaliu	6/18-19	46	63.0	30.4	—	—	93.4
"	6/19-20	65	50.7	41.5	—	—	92.2
"	6/20-21	107	56.0	32.7	—	—	88.7
Honaunau	1/16-18	223	64.1	1.8	—	—	65.9
"	1/18-20	193	56.5	4.7	—	—	61.2
Honaunau	1/19-20	29	82.8	3.4	—	—	86.2
"	1/20-25	127	44.1	0.8	—	—	44.9
Honaunau	2/2 - 3	237	49.3	4.6	—	—	53.9
"	2/3 - 8	514	28.9	7.5	—	—	36.4
Honaunau	2/9 -10	210	64.2	4.7	—	—	68.9
Honaunau	3/19-24	430	73.9	0.6	—	—	74.5
Honaunau	3/24-26	128	81.2	—	—	—	81.2
"	3/26-27	105	76.1	0.9	—	—	77.0
Honaunau	6/17-18	109	46.7	40.3	—	—	87.0
"	6/18-19	222	38.2	47.2	—	—	85.4
"	6/19-20	282	40.0	49.6	—	—	89.6
"	6/20-21	529	33.6	44.6	—	—	78.2
Honaunau	9/19-20	43	13.9	65.1	—	—	79.0
"	9/20-21	122	10.6	69.6	—	—	80.2
"	9/21-22	96	7.2	56.2	—	—	63.4
Kealakekua	2/6 - 8	82	79.0	—	—	—	79.0
Kealakekua	6/16-18	306	31.4	23.9	—	—	55.3
"	6/18-19	285	18.9	29.1	—	—	48.0
"	6/19-20	465	19.7	36.5	—	—	56.2
"	6/20-21	605	7.4	22.7	—	—	30.1
Kealakekua	9/18-19	34	17.6	67.6	—	—	85.2
"	9/19-20	39	23.0	56.4	—	—	79.4
"	9/20-21	91	37.3	48.3	—	—	85.6
"	9/21-22	173	24.8	42.7	—	—	67.5

[1] Each locality recorded in Tables I, II and III represents a separate lot of fruit from which larvæ were secured, and the first percentage under each lot is the percentage of parasitism of the first larvæ emerging. Each ditto mark represents the second, third or fourth lots of larvæ emerging from the same sample of fruit between the dates indicated.

and not from the ground. One specimen of *D. fullawayi* was reared from larvæ collected in coffee during January, or about one month after the first liberation of this parasite in Kona. The most interesting development, however, in the coffee section seems to be the gradual change taking place in the ratio of control exerted by the *O. humilis* and *D. tryoni* shown by the March, June and September data. This increase in effectiveness of *tryoni* seems to be taking place without producing an increase in the total parasitism, but at the expense of *O. humilis*. The percentages of parasitism among larvæ developing in kamani nuts (Table II) and other host fruits (Table III) show fewer negative results than those recorded for 1914. *D. fullawayi* appears to be very efficient in parasitizing larvæ in coffee cherries in Honolulu, and bids fair to outstrip the earlier introduced *O. humilis*. From larvæ reared from one lot of kamani nuts all four parasites are reared. From the general observations of the writers, it would appear that *T. giffardi* may prove a most valuable parasite in supplementing the good done by *humilis*, *tryoni*, and *fullawayi*. While all four species of parasites attack only the medium and well grown larvæ, *humilis*, *tryoni* and *fullawayi* are most active in parasitizing the mature larva while the host fruits are still attached to the trees. Although Mr. E. M. Ehrhorn has observed one specimen of *O. humilis* hovering over fallen Strawberry Guavas (*Psidium cattleyanum*), the writers have never observed *humilis*, *tryoni* or *fullawayi* attempting to oviposit in larvæ within fallen fruits. On the other hand, specimens of *T. giffardi* have been taken from the channels in the pulp of well decayed kamani nuts made by fruit-fly larvæ, and observations in the laboratory have proved that the adult female *Tetrastichus* will enter kamani nuts through breaks in the pulp and attack larvæ. As many as seventeen punctures have been counted in a single larvæ from which were dissected forty-one Tetrastichus eggs. Laboratory data have shown that the heaviest parasitism, especially during the warmer seasons of the year, when larval development and emergence is rapid, is to be found among the larvæ emerging during the first one or two days after the host fruits have been gathered. Since *humilis*, *tryoni* and *fullawayi* do not oviposit, or at most but slightly, in larvæ in fallen fruits, while *Tetrastichus* does to a much greater extent, it is to be expected that *giffardi* will be able to parasitize, as they become mature, those larvæ that were either unhatched or very young when the host fruit fell from the tree. In this connection, it is interesting to note that the highest percentages of parasitism due to *Tetrastichus* are shown in Table II, developing among larvæ bred from kamani nuts—a fruit always gathered from the ground.

TABLE II. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN KAMANI NUTS (*Terminalia catappa*) GROWING IN HONOLULU, T. H.

Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism				
			Opius humilis	Diachasma		Tetrastichus giffardi	Total
				tryoni	fullawayi		
1112 9th Ave.	9/27–10/4	15	6.6	—	—	—	6.6
Waialai Road	10/8 - 13	58	—	—	—	—	0.0
Ainahau	10/22- 25	22	9.1	—	4.6	—	13.7
Ainahau	10/29–11/1	176	12.0	—	—	—	12.0
Moana Hotel	11/27- 29	32	3.1	—	—	—	3.1
317 Richard St.	9/25–10/1	4	100.0	—	—	—	100.0
317 Richard St.	10/8 - 11	16	43.7	—	—	6.3	50.0
"	10/11- 13	37	32.4	2.6	—	—	35.0
317 Richard St.	10/12- 15	22	31.8	—	—	4.5	36.3
"	10/15- 18	12	8.4	—	8.4	—	16.8
317 Richard St.	10/15- 18	42	43.	—	—	4.7	47.7
"	10/18- 20	132	30.	1.5	—	—	31.5
317 Richard St.	10/16- 18	26	80.8	3.9	—	7.7	92.4
"	10/18- 20	71	63.4	4.2	—	4.2	71.8
317 Richard St.	10/19- 22	31	54.8	—	—	3.2	58.0
317 Richard St.	10/23- 25	71	74.6	—	—	7.0	81.6
Lunalilo and Piikoi St.	9/28–10/1	109	53.3	—	—	—	53.3
1327 Piikoi St.	10/2 - 6	53	24.5	—	—	—	24.5
1327 Piikoi St.	10/15- 18	61	62.3	—	—	—	62.3
1327 Piikoi St.	10/30–11/1	82	82.6	4.9	1.7	1.7	90.9
"	11/1 - 3	106	70.	6.6	—	—	76.6
Auld Lane	10/14- 18	24	66.7	—	—	—	66.7
Pawaa Junction	9/30–10/2	19	—	—	—	15.8	15.8
"	10/2 - 4	38	5.2	—	—	5.3	10.5
Pawaa Junction	10/8 - 11	10	—	—	—	40.0	40.0
Pawaa Junction	10/16- 25	120	0.8	—	—	—	0.8
Union St.	10/29–11/1	115	48.7	—	—	1.7	50.4
Queens Hospital	9/28–10/1	65	53.7	—	—	—	53.7
Queens Hospital	9/30–10/4	163	39.2	1.2	—	11.7	52.1
"	10/4 - 6	143	19.6	7.0	—	0.7	27.3
"	10/11- 13	7	—	—	—	14.3	14.3
Queens Hospital	10/5 - 6	8	13.	50.0	—	12.0	75.0
"	10/6 - 11	98	31.6	36.7	—	3.1	71.4
Queens Hospital	10/12- 15	19	47.4	5.3	—	—	52.7
"	10/15- 18	8	25.0	—	—	12.5	37.5
Capitol Gardens	9/28–10/1	11	45.5	—	—	—	45.5
Nuuana Cemetery	9/29–10/2	4	—	—	—	—	0.0
2030 Nuuanu St.	9/30–10/4	3	33.3	—	—	—	33.3
2425 Nuuanu St.	10/12- 15	5	60.0	20.0	—	—	80.0
2425 Nuuanu St.	10/20- 22	131	30.6	4.9	—	—	35.5
Judd and Liliha St.	10/14- 18	5	20.0	—	—	—	20.0
467 Judd St.	9/30–10/11	50	—	—	—	—	0.0
467 Judd St.	10/12- 22	76	—	—	—	—	0.0
467 Judd St.	10/14- 25	369	0.3	—	—	—	0.3
601 Judd St.	9/30–10/4	23	—	—	—	4.3	4.3
601 Judd St.	10/14- 25	16	—	—	—	—	0.0
Queen Emma Park	9/29–10/4	114	1.7	—	—	—	1.7
Queen Emma Park	10/8 -10/13	187	0.5	—	—	—	0.5
Upper Nuuana	10/15- 17	7	0	14.3	—	—	14.3

TABLE III. PERCENTAGE OF PARASITISM AMONG *C. capitata* LARVÆ DEVELOPING IN VARIOUS HOST FRUITS GROWN IN HONOLULU, T. H.

Host Fruits	Locality	Date of Larval Emergence	Total No. Pupæ Yielding Adults or Parasites	Percentage of Parasitism: Opius humilis	Diachasma tryoni	Diachasma fullawayi	Tetrastichus giffardi	Total
Eugenia[1]	St. Clements Ch.	9/30–10/4	9	22.2	—	—	—	22.2
"	"	10/4 - 8	54	1.8	—	3.6	5.5	10.9
"	Ainahou	9/29–10/4	16	6.2	—	—	—	6.2
Carambola[2]	1560 Beretania	9/28–10/1	3	33.3	—	—	—	33.3
Strawberry Guava	1804 College St.	9/30–10/4	14	42.9	—	—	—	42.9
"	Queen Emma Pk.	9/29–10/11	10	—	—	—	—	0.0
Mimusops elengi	Queens Hospital	10/23– 25	47	8.5	—	4.3	—	12.8
Natal Plum[4]	1814 Ahuula	10/20– 22	84	23.8	—	—	—	23.8
"	1814 Ahuula	10/26– 27	55	22.0	—	—	—	22.0
Hog Plum[5]	601, Judd St.	10/14–10/25	16	6.2	—	—	—	6.2
Lemon Guava[6]	1112 9th St.	10/21– 23	14	—	—	—	—	0.0
"	"	10/23– 25	71	8.4	—	4.2	—	12.6
	"	10/25– 29	382	5.2	—	—	—	5.2
	"	10/29–11/1	95	—	1.1	—	—	1.1
Chinese Oranges[7]	Punahou	9/28–10/1	44	4.5	—	—	—	4.5
	Punahou	10/2 - 4	8	50.	—	—	—	50.
	Punahou	10/11– 13	5	40.	—	—	—	40.
	Punahou	10/16– 18	10	40.	—	—	—	40.
	Punahou	10/19– 22	4	50.	—	—	—	50.
	Punahou	10/13– 15	7	—	29.6	—	—	29.6
	1427 Alexander	10/14– 18	18	17.9	—	—	—	17.9
	"	10/19– 22	16	25.	—	—	—	25.
	Ahua Lane	9/29–10/4	35	11.4	—	—	—	11.4
	248 Makee St.	9/29–10/1	22	36.4	—	—	—	36.4
	Kanaloa Lane	10/7 - 18	40	2.5	—	—	—	2.5
	Pauoa Valley	10/21– 25	12	33.3	—	—	—	33.3
Coffee[8]	Upper Manoa	10/13– 15	22	22.8	—	63.6	—	86.4
	"	10/15– 20	16	6.2	12.4	—	—	18.6
	1527 Makiki St.	9/30–10/6	3	33.3	—	—	—	33.3
	"	10/6 - 11	59	1.7	1.7	—	—	3.4
	1578 Luso St.	10/12– 6	195	35.9	—	18.0	—	53.9
	1578 Luso St.	10/21– 23	37	78.4	—	16.2	—	94.6
	Pauoa Valley	10/2 - 4	67	50.0	—	—	—	50.0
	"	10/4 - 6	140	2.1	—	1.5	—	3.6
	Pauoa Valley	10/21– 23	27	11.1	—	78.0	—	89.1
	"	10/23– 25	102	16.6	—	69.6	—	86.2
	Queens Hospital	10/26– 27	11	27.2	—	36.3	—	63.5
	Washington Pl.	10/26– 29	21	62.0	—	38.0	—	100.0

[1] *Eugenia michelii.* [2] *Averrhoa carambola.* [3] *Psidium cattleyanum.* [4] *Bunchosia sp.*
[5] *Spondias lutea.* [6] *Psidium guayava.* [7] *Citrus japonica.* [8] *Coffea arabica.*

While it is far too early to draw any conclusions regarding the ultimate effectiveness of these introduced parasites, data for 1914 and 1915 show that all four parasites have successfully established themselves, and are already promising much as a factor in the control of Hawaii's worst fruit pest, and form a basis for the study of the relationship between the parasites in their struggle for existence during the years to come.

SOME GRASS-FEEDING MEALY-BUGS (COCCIDÆ)

By T. D. A. Cockerell, *University of Colorado*

I am indebted to Mr. P. H. Timberlake for some beautiful mounts of certain grass-feeding mealy-bugs, which he wishes to mention by name in an account of the parasites raised from them. They prove to belong to the group of *Pseudococcus neomexicanus* (Tinsley), but to differ from any previously described.

Pseudococcus timberlakei n. sp.

Female. Body elongate, 2,016 microns long and 800 broad, as mounted; scattered hairs and many small round glands, but no lateral patches of bristles; caudal region with many glands, of two sizes, large and ring-like, and small with a distinctly cylindrical form; antennæ wide apart (167 microns), 8-jointed; labium 112 microns long and 72 broad at base; legs with long hairs, on under side of middle femur are seven long hairs (75 microns), in two rows; no denticle on claw; anal ring with six bristles, 145 microns long; long bristles of caudal lobes about 195 microns. The following measurements are in microns: middle leg, femur with trochanter, 250; tibia, 187; tarsus (without claw), 80. Antennal joints: (1) 45–47, (2) 50, (3) 42, (4) 32–35, (5) 35–40, (6) 32–35, (7) 37, (8) 80.

Mr. Timberlake's field notes are as follows:

"On salt marsh grass, Millbrae, California (near San Francisco), Oct. 14, 1915. Half-grown specimens or larger were found in exposed situations on blades or at axils of the blades, and females with egg-masses on the same parts of the plant. The lateral and caudal secretions of the active females closely resemble those of *Pseudococcus citrophilus* Clausen figured on p. 20, Calif. Exp. Station Bull. 258. (I made comparison with figure given as soon as I got back from the field.) The egg-mass or sac is rather compactly matted, about 4 mm. long and 1.5 in diameter, and the exhausted female lies exposed at one end."

The antennæ agree with those of *P. neomexicanus*, but the other characters are distinctive. The species is easily known from *P. salinus* Ckll. (which may be found in quantity on grass at the edge of the low cliff at the Scripps Institution at La Jolla, California) by the much longer bristles of anal ring and caudal bristles, as well as by the shorter first three antennal joints.

Mr. Timberlake sent for comparison a slide marked "*Pseudococcus smithii* (Essig), on *Elymus*, Ventura, Calif., Oct. 20, 1914 (C. P. Clausen)." This is said to be the species described from examples with 7-jointed antennæ as *Ripersia smithii* Essig; Mr. Clausen found that a considerable proportion of the specimens had 7-jointed antennæ, but 8-jointed specimens were not rare. The insect is a true *Pseudococ-*

cus, but very distinct from *P. timberlakei*, especially in the character of the antennæ. The following measurements in microns are from the specimen sent to me: hind tibia, 375; hind tarsus (without claw) 117; hairs of anal ring, about 125; long caudal bristles about 180; antennal joints, (1) 80, (2) 80, (3) 60, (4) 57, (5) 62, (6) 55, (7) 47, (8) 107. This is certainly not *salinus;* it appears to be related to *P. maritimus* (Ehrhorn).

Pseudococcus neomexicanus var. *utahensis* n. var.

FEMALE. Length 4.5 mm., width 2 mm.; claws without denticle, all the digitules slender. Agrees in general with *neomexicanus*, but third antennal joint *much* shorter than second, and equal with 4, 5 and 6. The following measurements are in microns: hairs of anal ring about 107; long caudal bristles about 150; middle leg, femur with trochanter, 195; tibia, 160, tarsus (without claw), 75; width of femur, 40; antennal joints, (1) 42, (2) 42–45, (3) 25, (4) 25–27, (5) 25–27, (6) 25, (7) 35, (8) 72. Collected Sept. 3, 1915.

Mr. Timberlake's field notes are as follows:

"On *Elymus*. Salt Lake City, Utah. This species was first noticed by me about the middle of July, but no collection was made until Aug. 14. Other collections were made Sept. 3, Sept. 20 and Nov. 23. All the larger specimens were found concealed between the sheaths and the stem, and hence they could not be observed in an undisturbed condition. Apparently when the females reached a fairly large size (about half grown) they became enclosed in rather thin cottony sacs of rather close texture. A female that was removed from its situs and placed in a vial, soon entirely enclosed itself in a cilindrical cottony mass about 6 mm. long and 2 mm. in diameter. This sac was apparently much more abundantly developed and certainly considerably more fluffy than in specimens taken from the stems. Those in stems were of course much flattened and the cottony secretion pressed together. A female with egg-mass of 103 eggs, collected on Nov. 23, was found at one end of sac, and not covered up, at least when leaf-sheath was torn away; neither were the eggs entirely covered up, but the cottony fibers being sticky (but not viscid) tenaciously held the eggs in place. The body coloration was not noted, certainly not striking, and if I remember right pale yellowish. The females removed from their sacs were covered with a thin white meal, and nearly destitute of the usual lateral and caudal secretions. The exhausted female found on Nov. 23 turned dull, dark, crimson-brown when boiled in KOH. The egg was described as pale yellowish-brown, darker at one end, about .4 mm. long by .2 mm. diameter."

True *P. neomexicanus*, common in northern New Mexico, lives underground on roots of grass, and is tended by *Lasius*.

Scientific Notes

New Jersey Mosquito Association Meets. This organization, which has for its object the elimination of the mosquito from the standpoint of human comfort and the attendant property values, held its third annual meeting on the 17th and 18th of February. As might be expected from its purpose the membership is composed of business and professional men of all sorts. To become a member it is merely necessary to inform the proper persons that one wishes to become connected with the movement. No dues or assessments are levied upon the individual members and the necessary expenses are borne by the organizations which belong to it.

The program of this meeting included five speakers, who were professionally connected with the practical work; eleven, who were identified with it as members of directing boards; two who were responsible for the state work and the correlation of the work of the county units; three who represented the taxpayers who receive the benefits and pay the bills; one, who represented the Interstate Anti-mosquito Committee; and one, who represented the mosquito work of the country as a whole.

One member of the first group, Mr. James E. Brooks, showed that dikes, tide gates, and trenching, drain shut-in areas of salt marsh, which the ordinary trenching will not protect, in such a fashion that no serious emergence of mosquitoes takes place. Another member, Mr. William Delaney, pointed out that pumps are necessary on certain enclosed marshes that have shrunken below the sea level, and that a twelve-inch, low-head, motor-driven, centrifugal pump with necessary trenching removed the water from 800 acres of bad breeding marsh in such a fashion that no serious emergence could occur.

Another member of this group, Mr. Harold I. Eaton, showed that the average acre cost of salt marsh trenching for 12,000 acres drained in the last three years was $4, and that the price exclusive of administration expense had been reduced from $5.22 in 1913 to $2.75 in 1915. Another member, Mr. Russell W. Gies, showed that the average per capita cost of county-wide mosquito control work was about 12 cents. Another, Mr. John Dobbins, pointed out the methods, which four years' experience in the practical work had proven to be best for fresh water mosquito control.

The members of the second group, Dr. William Edgar Darnall, Mr. E. B. Walden, Mr. Joseph Camp, Mr. Spencer Miller, Dr. H. H. Brinkerhoff, Mr. Charles Deshler, Mr. Ira Barrows, Mr. Walter Hudson, Mr. Robert F. Engle and Mr. Louis J. Richards, confined their statements to the status of the practical work in the counties which they represented.

The first member of the third group, Dr. Jacob G. Lipman, pointed out the tremendous agricultural and urban development which awaits the satisfactory control of the mosquito pest. The second, Dr. Thomas J. Headlee, pointed out the various problems of the New Jersey mosquito's natural history and control that have been recently solved and some of those which still await solution.

The members of the fourth group, Mr. Thomas Mathias, Mr. E. Morgan Barradale, and Mr. John N. Cady, devoted their attention to the results of the work (which they said were good) and the esteem (which they said was high) in which it is held by those who pay the bills.

Dr. Haven Emerson, commissioner of health for New York City, and member of the fifth group, outlined the work of this committee as one of correlating the mosquito control work of Connecticut, New Jersey and New York.

Dr. L. O. Howard discouraged the use of bats as a means of mosquito control in New Jersey on the ground that natural conditions did not favor the attempt. He set forth the work of King connecting *Anopheles punctipennis* Say. with the carriage of malaria and gave a brief account of the Bureau's work against the malarial mosquito in the lower Mississippi valley.

The following officers were elected for the ensuing year: President, William Edgar Darnall, M. D., Atlantic City; first vice-president, H. H. Brinkerhoff, M. D., Jersey City; second vice-president, Robert F. Engle, Beach Haven; secretary-treasurer, Thomas J. Headlee, Ph.D., New Brunswick.

The proceedings will be published.

Conference of Officials Engaged in Gipsy Moth Work. A conference of Officials Engaged in Gipsy Moth Work was held in Boston on February 15, 1916. Dr. L. O. Howard, chief of the Bureau of Entomology, presided and the following officials and visitors were present.

Dr. C. Gordon Hewitt, Dominion Entomologist, Ottawa, Canada.

Mr. John D. Tothill, Field Officer, Entomological Branch, Fredricton, N. B.

Mr. L. S. McLaine, Field Officer, Entomological Branch, Fredricton, N. B.

Mr. G. E. Sanders, Field Officer, Entomological Branch, Annapolis Royal, N. S.

Mr. E. J. Cadey, Special Agent, in Charge of Gipsy Moth Work, Portland, Me.

Prof. W. C. O'Kane, Deputy Commissioner, In Charge of Moth Work, Durham, N. H.

Mr. W. O. Osgood, Assistant in Gipsy Moth Work, Durham, N. H.

Mr. H. L. Bailey, In Charge of Suppression of Insect Pests, Bradford, Vt.

Dr. H. T. Fernald, State Inspector of Nurseries, Amherst, Mass.

Mr. R. H. Allen, Assistant Inspector of Nurseries, Boston, Mass.

Mr. C. O. Bailey, Secretary, Massachusetts State Forester, Boston, Mass.

Mr. George A. Smith, Assistant, Massachusetts State Forester, Boston, Mass.

Mr. Paul D. Kneeland, Assistant, Massachusetts State Forester, Boston, Mass.

Mr. Harry B. Ramsey, District Moth Superintendent, Worcester, Mass.

Mr. Harold L. Neale, City Forester, Worcester, Mass.

Mr. Allen Chamberlain, Massachusetts Forestry Association, Boston, Mass.

Mr. Harry Horovitz, Assistant Entomologist, Providence, R. I.

Mr. I. W. Davis, Assistant Entomologist, New Haven, Conn.

Dr. G. G. Atwood, Chief, Bureau of Horticulture, Albany, N. Y.

Mr. Harry B. Weiss, Assistant Entomologist, New Brunswick, N. J.

Mr. E. R. Sasscer, Chief Inspector, Federal Horticultural Board, Washington, D. C.

Mr. R. I. Smith, Quarantine Inspector, Federal Horticultural Board, Boston, Mass.

The following assistants of the Bureau of Entomology, engaged on Gipsy Moth Investigations, were also present: A. F. Burgess, J. W. Chapman, G. E. Clement, C. W. Collins, S. S. Crossman, R. W. Glaser, H. L. McIntyre, C. W. Minott, Willis Munro, D. M. Rogers, C. W. Stockwell, J. N. Summers and L. H. Worthley.

The meeting was called for the purpose of conferring on gipsy moth and brown-tail moth problems and reports were given as to moth conditions in each state and the Dominion of Canada.

The morning session was occupied with these reports and their discussion.

In the afternoon reports were made by different members of the Federal force. A report was given on each line of work and a general discussion followed. Those who attended expressed the opinion that much benefit had been secured at the conference. An invitation was presented to those who attended as well as to a number of states that were not fully represented, to inspect the field work early in July.

In the evening many of those who attended the conference were present at the regular meeting of the Cambridge Entomological Club. After the regular program of the club had been completed, interesting remarks were made by Doctor Howard, Doctor Hewitt, Doctor Wheeler, Doctor Fernald, and Doctor Johnson.

On Thursday morning a number of the officials took advantage of the opportunity to visit the Gipsy Moth Laboratory at Melrose Highlands, Mass., and inspect the work which was being carried on there and examine the equipment and apparatus which is used in the field work.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The recent proof[1] that *Anopheles punctipennis* Say. is a host of tertian malaria is of great interest and importance. For some sixteen years, it has been known that another species, *Anopheles quadrimaculatus* Say., was able to transmit this disease through its bites, and though *punctipennis* has always been suspected, most of the experiments gave only negative results. Mr. King has now caught the criminal "with the goods." In Connecticut, at least, where both species occur, *A. punctipennis* is far more common than *A. quadrimaculatus*, as evidenced by the adults reared from *Anopheles* larvæ, and this discovery readily explains the prevalence of malaria in sections where it is extremely difficult to find *A. quadrimaculatus*. Now that it has been shown that *punctipennis* is also guilty, the very abundance of this species ought to stimulate the people to take active measures for its suppression in nearly every locality.

W. E. B.

The appearance in the past few months of three volumes, each different, though excellent in its way, on the honey bee, augers an increased interest in this ancient friend of man and should eventuate in many additional apiaries, especially small ones, throughout the country. Much has been written lately on the conservation of natural resources, mostly by those who know little of the honey bee and its possibilities.

[1] W. V. King, American Journal of Tropical Diseases and Preventive Medicine, Vol. III, page 426, February, 1916.

There should be a few to a number of hives on every farm. The returns from each would not be large and yet the value of the aggregate production would amount to an enormous sum. This type of conservation requires no preliminary legislation, simply a little individual initiative. The section of Apiary Inspection has already done much to popularize bee-keeping and entomologists generally will find it decidedly advantageous to give due emphasis to this phase of their work.

Reviews

Productive Bee-keeping, Modern Methods of Production and Marketing of Honey by Frank C. Pellett, pp. i–xiv, 1–302, 134 text figures, 1916. J. B., Lippincott Company, Philadelphia and London. $1.50 net.

This attractive addition to Lippincott's Farm Manuals abounds in excellent illustrations and is evidently written by one in love with his work. The subject-matter is presented in an admirable manner, the author at the outset dwelling upon the friendly relations which should exist between the bee-keeper and his charges, and incidentally commends them to the attention of the nature-lover.

The business opportunities are discussed in a somewhat conservative though optimistic manner and there is no doubt but that the country would be materially benefited if bee-keeping was more general. The beginner will find in this work commonsense suggestions for starting and managing an apiary, all phases being considered from the location of the apiary to the removing and marketing of the honey. There is a full discussion of bee diseases, an interesting chapter on laws that concern the bee-keeper and at the end of each chapter a number of questions, evidently designed to facilitate the use of the volume as a text-book. Both amateur and professional will find much of interest and value in this addition to the long series of bee books (*Advertisement*).

The Ecological Society of America. A meeting of ecologists was held at Columbus in Convocation Week to take action upon the proposal made at the Philadelphia Meeting for the formation of a society of ecologists. Over fifty persons were present and the Organization Committee held letters from about fifty others who expressed interest in the project. In view of these facts it was unanimously voted to organize under the name, The Ecological Society of America. It was decided to enroll as charter members not only those present at the organization, but also those who had by letter expressed a desire to be included in the membership, as well as those joining prior to April 1, 1916. A constitution which had been drafted by the Organization Committee was adopted, and the following officers were elected: President, Prof. V. E. Shelford, of the University of Illinois; vice-president, Prof. W. M. Wheeler, of Harvard University; secretary-treasurer, Dr. Forrest Shreve, of the Desert Laboratory. The first regular annual meeting will be held in New York during the next Convocation Week, where a program will be arranged in harmony with the programs of other societies, so as to minimize serious conflict. Frequent field meetings will be held under the auspices of the society,—four having already been arranged for the coming summer. Several proposals for the carrying out of coöperative investigations are also being entertained by the members of the society.

Current Notes

Mr. W. V. King, Bureau of Entomology, stationed at New Orleans, attended a conference at Washington on January 3.

Mr. A. H. Jennings, Bureau of Entomology, was on furlough for the months of December, January and February, on account of ill health.

Mr. T. E. Holloway, Bureau of Entomology, in charge of the laboratory at New Orleans, was in Washington during the month of February.

The following agents of the Bureau of Entomology were in Washington for conference during the month: F. C. Bishopp, A. C. Morgan, E. A. McGregor, B. R. Coad, G. L. Garrison and T. F. McGehee.

Mr. A. W. Yates, apiary inspector of Hartford, Conn., has been engaged to give a course in beekeeping at the Connecticut Agricultural College at Storrs.

Mr. L. P. Rockwood, Bureau of Entomology, whose address was originally Room 416, Vermont Building, Salt Lake City, Utah, has removed to Forest Grove, Ore.

Mr. E. L. Barrett, Bureau of Entomology, has been transferred from the Pasadena, Cal., laboratory to assist Mr. E. G. Kelly at the Wellington, Kan., Field Laboratory.

Dr. L. O. Howard planned to visit the field stations located at Orlando and Gainesville, Fla., Thomasville, Ga., and Columbia, S. C., during the early part of March.

Mr. L. G. Gentner, formerly of the Branch Experiment Station at Medford, Ore., is now a member of the Department of Entomology, University of Wisconsin, Madison, Wis.

Dr. Julius Nelson, Professor of Biology at Rutgers College since 1888, died from an attack of pneumonia at his home in New Brunswick, February 16, aged 58.

Prof. H. A. Surface, Economic Zoölogist of Pennsylvania, gave four lectures on wild animal life before the students of the Yale Forest School the latter part of February.

Prof. S. W. Williston has recently been elected a fellow of the American Academy of Arts and Sciences, and a correspondent of the Academy of Natural Sciences of Philadelphia.

Mr. C. K. Wildermuth, Bureau of Entomology, recently attached to the staff at the Maxwell, N. M., field station, has resigned in order to continue his studies.

Mr. Daniel G. Tower, Bureau of Entomology, recently located at the West Lafayette, Ind., field station, has been transferred to the office of Tropical and Subtropical Fruit Investigations.

Dr. E. F. Phillips, Bureau of Entomology, attended the annual convention of the National Beekeepers' Association at Chicago, Ill., February 22–24. Prof. Francis Jager was elected president.

The Nashville, Tenn., Field Laboratory, Bureau of Entomology, was moved to Knoxville, Tenn., about March 1, 1916. The present staff at Nashville was transferred to the Knoxville Station.

Professor G. M. Bentley, State Entomologist of Tennessee, with headquarters at Knoxville, is Secretary-Treasurer of the Tennessee Florists' Association.

Mr. C. W. Creel, of the Forest Grove, Ore., field station, Bureau of Entomology, was in Washington during the month of January.

Mr. T. D. Urbahns of the Pasadena, Cal., field laboratory, Bureau of Entomology, visited Washington during the month of January for the first time in several years.

Mr. F. C. Bishopp, Bureau of Entomology, in charge of the laboratory at Dallas, Texas, underwent a serious operation at that place during February. His condition is greatly improved.

Dr. Charles H. T. Townsend of the Bureau of Entomology gave an illustrated lecture on Verruga before the students of the medical school of Howard University, Washington, D. C., January 15.

Mr. G. G. Ainslie of the Nashville, Tenn., field laboratory, Bureau of Entomology, visited Washington during the early portion of January for the purpose of consultation and preparation of manuscript.

Mr. A. J. Ackerman, Bureau of Entomology, who has been working on nursery insects at West Chester, Penn., has recently visited Washington in connection with the preparation of his field notes.

Mr. E. W. Geyer, Bureau of Entomology, who has been in Washington preparing manuscript on the biology of the codling moth in New Mexico, has returned to his field station at Roswell.

According to *Science*, it is planned to erect a monument on the Roman Campagna in memory of Prof. Angelo Celli, who made important investigations there regarding malaria and its transmission by mosquitoes.

According to *Science*, Mr. C. A. McLendon, formerly field pathologist of the South Carolina Agricultural Experiment Station, has accepted a position as expert in cotton breeding with the Georgia State Board of Entomology, Atlanta, Ga.

Mr. C. M. Packard, Bureau of Entomology, formerly attached to the staff at the Wellington, Kan., Field Laboratory, has been transferred and detailed to assist Mr. T. D. Urbahns at the Pasadena, Cal., Field Laboratory.

Mr. George S. Demuth, Bureau of Entomology, attended the annual meeting of the Kentucky Beekeepers' Association at Lexington, January 5, and of the New Jersey Beekeepers' Association at New Brunswick, February 10–11.

According to *Science*, Prof. V. L. Kellogg, who has been serving as a director of the Belgium Relief Commission in Brussels for the past eight months, has returned to take up his work at Stanford University.

Dr. W. J. Holland, director of the Carnegie Museum, gave the principal address at the formal opening of Alden Hall of Biology at Allegheny College, February 4. His subject was "Biology a Cultural and Practical Study."

Prof. Stephen Alfred Forbes, of the University of Illinois, and Prof. Samuel Wendell Williston, of the University of Chicago, were elected honorary fellows of the Entomological Society of America at its meeting at Columbus, Ohio.

Mr. C. N. Ainslie of the Elk Point, S. D., field laboratory, Bureau of Entomology, visited Washington during the winter for the first time in seven years, for the purpose of consultation and the preparation of manuscript.

Mr. A. I. Fabis, Bureau of Entomology, has returned to his field station at Monticello, Fla., after spending some time in Washington. He will resume his duties at Monticello, assisting Mr. Gill in pecan-insect investigations.

The following were among the visitors at the Bureau of Entomology, Washington, D. C., during December: Wilmon Newell, Plant Commissioner of Florida; J. T. Crawley, Director of the Cuban Experiment Station; A. H. Rosenfeld, Director of the Tucuman Experiment Station, and Prof. C. T. Brues, of Bussey Institution.

According to *Science*, Dr. L. O. Howard, Chief of the Bureau of Entomology of the U. S. Department of Agriculture, will give the evening lecture at the general meeting of the American Philosophical Society on the evening of April 14. The subject will be, "On Some Disease-bearing Insects."

Mr. H. G. Ingerson, Bureau of Entomology, who has been assisting Mr. F. L. Simanton at Benton Harbor, Mich., in orchard insecticide investigations, has been in Washington for the purpose of preparing notes on the subject of his field investigations and library work.

Mr. W. D. Hunter, Bureau of Entomology, in company with G. B. Sudworth of the Forest Service, both members of the Federal Horticultural Board, visited Boston during the month of January in connection with the preparations for the fumigation of all foreign cottons arriving in the United States after February 1.

Mr. E. G. Carr, State Apiary Inspector of New Jersey, has recently been employed by the Bureau of Entomology to make a survey of the present conditions and possibilities of beekeeping in the state of North Carolina. He finds the outlook most promising and spent the month of January in Washington making out reports on this line of work.

Mr. C. M. Packard, recently attached to the staff at the Wellington, Kan., field laboratory, Bureau of Entomology, was in Washington during a portion of the month of January. Mr. Packard has in preparation a paper dealing with the biology of several parasites of the Hessian fly.

Mr. F. L. Simanton, Bureau of Entomology, who has been engaged in investigations of orchard insecticides and spraying machinery, with headquarters at Benton Harbor, Mich., visited Washington recently for the purpose of summarizing notes on the subject of his field investigations, preparation of manuscripts and library work.

A letter written by A. W. J. Pomeroy from Kamerun, West Africa, on November 7, 1915, reached Washington on March 2. Mr. Pomeroy is now a lieutenant in the West African Frontier Force. He has been ill with some tropical fever but at the time of writing was on active duty.

A course of fifteen public lectures on tropical medicine is being given Saturday mornings at the University of California. Dr. E. L. Walker gives five of these lectures and his subject for April 15 is "Parasitic Insects and the Rôle of Insects in the Transmission of Tropical Diseases."

Dr. E. F. Phillips, Bureau of Entomology, attended ten conventions of beekeepers in the Middle West during November and December, these being arranged in a

circuit for the convenience of those outside the various states who desired to attend. The meeting at Grand Rapids, Mich., was the fiftieth annual convention of Michigan beekeepers.

The onion thrips, according to Mr. M. M. High, Bureau of Entomology, is about as abundant as usual in south Texas, more so than in the previous year, and he is of the opinion that it will increase in numbers unless checked. The growers generally are handling the proposition very well, especially at Mission, Texas.

Prof. Herbert Osborn was given a dinner at the Chittenden Hotel, Columbus, Ohio, December 29, 1915, by about forty of his former students. The guest of honor was presented with some verses entitled "Herbert Osborn, an Appreciation," by J. G. Sanders, and the signatures of the other students, on vellum, appropriately illuminated in black, red and gold.

A course of twelve lectures was given in February, March and April by members of the Staff of the New York State Museum, in the Education Building, Albany, N. Y. This course included two lectures dealing with insects,—"Man and Insects" by Dr. E. P. Felt, and "Harmonics and Cross Purposes in the Insect World" by F. T. Hartman.

At the annual meeting of the Brooklyn Entomological Society, held on January 13, the following officers were elected for 1916: President, W. J. Davis; vice-president, W. T. Bather; treasurer, Chris. E. Olsen; recording secretary, J. R. de la Torre Bueno; corresponding secretary, R. P. Dow; librarian, A. C. Weeks; curator, George Franck; publication committee, C. Schaeffer, R. P. Dow, and the recording secretary, *ex-officio*.

Mr. E. G. Smyth, from the office of the Commissioner of Agriculture at Rio Piedras, Porto Rico, recently visited Washington for consultation in regard to cooperative work in Porto Rico on insects which occur on that island as well as in the Gulf region.

Mr. D. E. Fink, Bureau of Entomology, visited Washington during January. He is engaged in making a special study of cucurbitaceous insects and their rôle as transmitters of the virus of wilts and mosaic diseases. He has also conducted similar studies on the springtails, the spinach aphis, and other truck crop insects which have been injurious during the past year at Norfolk, Va.

Mr. A. B. Champlain, Bureau of Entomology, stationed at Lyme, Conn., left Washington on January 24 after several days of consultation and study of literature and collections. On his return trip he stopped at Huntington, L. I., and assisted Mr. Griffith in the study of the insects in connection with the demonstration control against the hickory bark beetle and two-lined chestnut borer.

The Ohio State University has recently inaugurated a plan providing for Research Professors which enables the holders to devote their time especially to research work and Professor Herbert Osborn has been elected Research Professor in the Department of Zoölogy and Entomology. He will be relieved from routine, class and department duties, devoting his time to research, especially in the line of Entomology, but will continue to have direction of research work of Graduate students in his particular field.

A recent inspection by Mr. T. E. Snyder of the experimental and demonstration control project in the White Top Purchase Area, Tennessee and Virginia, conducted

by the Forest Service under the advice and instructions of Dr. A. D. Hopkins, shows that there is every indication from the relative number of black tops, brown tops and newly infested trees, that there is a marked decrease in the infestation and that a destructive invasion has been checked.

Dr. Donaldson Bodine, professor of geology and zoölogy at Wabash College, died recently at forty-nine years of age. Doctor Bodine graduated from Cornell University in the Class of 1887, and received the degree of Doctor of Science from his alma mater in 1895. While pursuing graduate studies at Cornell he did considerable work on the histology and taxonomy of insects—especially Lepidoptera. For several years Doctor Bodine has been dean of the faculty at Wabash.

The annual meeting of Entomological Workers in Ohio State Institutions was held in Room 100, Botany and Zoölogy Building, Ohio State University, Columbus, Ohio, Tuesday, February 1, 1916. This meeting was open to the public and the following program was carried out:

Present Problems of Inspection Work, by N. E. Shaw.

General Reports from Heads of Department Organizations, by H. A. Gossard, N. E. Shaw, and Herbert Osborn.

Ten Minute Report by Individual Investigators:

- Review of Projects. Insect Transmitters of Fire-blight, by H. A. Gossard.
- Review of Projects. Photography as an Aid to Insect Study, by W. H. Goodwin.
- Review of Projects. City Problems of Insect Control, by J. S. Houser.
- Review of Projects. Food Records of Pentatomids, by R. D. Whitmarsh.
- Review of Projects. Progress Report on Ox Warble Fly Investigations, by D. C. Mote.
- Review of Projects, by J. L. King. Presented by H. A. Gossard.
- Orchard Inspection, by E. J. Hoddy.
- Quarantine on Christmas Trees and Greenery from Gypsy Moth Area of New England, by H. E. Evans.
- Report of Control of Gypsy Moth Outbreak, by H. J. Speaker.
- Apicultural Work, by James S. Hine.
- Observations on Spiders of Ohio, by William M. Barrows.
- Life Histories of Syrphidæ, by C. L. Metcalf.
- Records of Exotic Orthoptera in Ohio, by W. J. Kostir.
- Hemiptera-Heteroptera of Southeastern Ohio, by C. J. Drake.
- Additional Records in Ohio Homoptera, by Herbert Osborn.

Reports on the investigation, instruction and demonstration control work carried on during the past season by the Bureau of Entomology, in connection with a study of present infestation by *Dendroctonus* beetles in the Yosemite National Park in coöperation with the Interior Department, show that the control work carried on by the Interior Department during the past three years, under recommendations of the Forest Entomologist, has resulted in bringing the infestation of the entire park under sufficient control as to require but little attention during the coming season.

At the tenth annual meeting of the Entomological Society of America, held at Columbus, Ohio, December 29 and 30, the following officers were elected: President, F. M. Webster, U. S. Bureau of Entomology; first vice-president, E. P. Felt, New York State Entomologist; second vice-president, A. L. Melander, Washington State College; secretary-treasurer, J. M. Aldrich, U. S. Bureau of Entomology, West Lafayette, Ind.; additional members of the executive committee, H. T. Fernald, Massachusetts Agricultural College; W. E. Britton, State Entomologist of Connecti-

cut; P. J. Parrott, Entomologist, New York Agricultural Experiment Station; E. D. Ball, Oregon Agricultural College; C. Gordon Hewitt, Dominion Entomologist.

The Second Pan-American Scientific Congress was held in Washington, December 27, 1915, to January 8, 1916. One of its numerous sections was entitled "Conservation of Plant Life," and under this section there was one session in which papers were presented bearing upon the general subject of quarantine, in which entomologists were interested. Mr. Marlatt, Chairman of the Federal Horticultural Board, and Dr. L. O. Howard, Chief of the Bureau of Entomology, took part in this discussion.

A community demonstration on methods of control of *Scolytus quadrispinosus* in hickory, and *Agrilus bilineatus* in oak on Long Island is being made under the specific direction of Dr. A. D. Hopkins, Bureau of Entomology; 942 infested hickories and 911 infested oaks, within an area of 1,200 acres and involving six estates, were marked during the fall for treatment. At present the control work is being carried on by owners with special energy. Both the marking and control work are under the immediate supervision of the assistant in shade tree work, Mr. L. C. Griffith.

The present regulations of the U. S. Department of Agriculture require that a copy of every manuscript intended for publication outside of the Department be submitted to the Assistant Secretary for filing in his office. It will save considerable work and time if Department agents who submit manuscripts for publication outside of the Department send in three copies, one to be filed in the office of the Assistant Secretary, one to be sent to the publishers, and the third to be filed in the Bureau with which they are connected.

It has been observed by members of the Bureau of Entomology that the cabbage looper (*Autographa brassicæ*) has different habits according to the region in which it occurs, due doubtless to climate, heat and cold, and environment. This species can be easily controlled in Tidewater, Va., but it is more difficult to destroy in the Atlantic region of the North. There is no evidence that when this species occurs in Tidewater, Va., it cannot be controlled by almost any spray since the conditions there are quite favorable for infection by a bacterial disease. The combination of the disease and poisons kills a high percentage of the larvæ.

Theodore Pergande, the oldest scientific assistant in point of continued service in the Bureau of Entomology of the U. S. Department of Agriculture, died on March 23, in Washington, at the age of seventy-six. He was born in Germany; came to America at the outbreak of the Civil War; served through the war in the northern army, and later became assistant to the late C. V. Riley when the latter was state entomologist of Missouri, coming with him to the Department of Agriculture at Washington in June, 1878. He was a keen observer of the structure and habits of insects, and was especially noted for his work on the Aphididæ.—*From Science*.

According to the *Experiment Station Record*, four new entomological laboratories were completed in Canada during the summer of 1915, located respectively at Annapolis Royal, N. S.; Fredericton, N. B.; Treesbank, Man.; and Lethbridge, Alb. The laboratory at Fredericton is the most elaborate of these structures and is a two-story and basement brick building 24 by 30 feet, located on the campus of the University of New Brunswick. Its work has been especially directed toward the natural control of insects, notably the brown-tail moth, tent caterpillar, spruce budworm, and fall webworm. The laboratory at Annapolis Royal is a wooden one-story and basement building, 26 feet square. It is located on the county school grounds and is equipped with special reference to combatting the brown-tail moth and for studies

of the bud moth, fruit worm, and other fruit pests. It replaces a former temporary laboratory at Bridgetown, which is to be used as a substation wherever most needed. The laboratories at Treesbank and Lethbridge are of the bungalow type, the former being 12 by 16, and the latter, located on the Dominion substation farm, 23 by 20 feet.

Dr. E. A. Back, of the Bureau of Entomology, has substantially completed his work in Honolulu and will shortly report to Washington to complete the general bulletin on the Mediterranean fruit fly. Mr. C. E. Pemberton will remain in Honolulu in charge of the work, assisted by Mr. Willard, who is in direct charge of the inspection and certification of export fruits in coöperation with the Federal Horticultural Board of the United States Department of Agriculture. The future development of the research work in the Hawaiian Islands in relation to the fruit fly will be determined after Doctor Back returns to Washington. Doctor Back has recently submitted to the home office a very interesting book of photographs illustrating the fruit-fly work and conditions in Hawaii. In this book are photographs of drawings of four of the introduced parasites. *Opius humilis* is the one which has hitherto been reported as being so efficient in its parasitism of larvæ, particularly on coffee plantations. Among the parasites figured, however, is a species, *Diachasma fullawayi*, more recently established, which, within a single year, has so increased that in one collection of coffee berries, 92 per cent of the larvæ were found parasitized. Further details relative to these and other parasites are given in papers already published by Doctor Back.

The work of the Bureau of Entomology on animal parasites is in direct charge of Mr. F. C. Bishopp at Dallas, Texas. At that place Messrs. H. P. Wood and E. W. Laake are located continuously, and Mr. W. E. Dove is present during the winter months. The work conducted follows a considerable number of lines, among which may be mentioned the work on the biology and control of the various ticks, ox warbles, stable fly, horn fly, and pests of poultry, including lice, mites and fleas; also on the control of flies about slaughter and packing-houses. Temporary field laboratories are established in regions where losses are most severe. One of these substations is located at Uvalde, in the semi-arid region of Texas. Mr. D. C. Parman, who is located here, devotes the major part of his time to investigations of the so-called screw worm, and to certain speeies of Tabanidæ which are very abundant and also concerned in the transmission of anthrax. Mr. J. D. Mitchell, with headquarters at Victoria, Texas, devotes a portion of his time to work on insects affecting live stock. Mr. W. E. Dove, during the past season, conducted investigations on the horse bots, particularly *Gastrophilus hæmorrhoidalis*, at Aberdeen, S. D. Arrangements have been made for the study of Tabanidæ, which are important pests of live stock in parts of Nevada and California, in coöperation with the experiment station of Nevada. It is possible also that other work with horseflies will be taken up in the swampy area in southeastern Texas and southern Louisiana during the coming year. It is hoped that various agents of the Bureau will assist as far as possible in this work by making notes on insects affecting animals when such occurrences come to their notice in connection with their other work. Specimens of various animal pests will also be gratefully received at the Dallas laboratory.

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DISPERSION OF MUSCA DOMESTICA LINNÆUS UNDER CITY CONDITIONS IN MONTANA

Contribution from the Laboratory of the Montana State Board of Entomology, State College, Bozeman, Mont.

By R. R. PARKER

INTRODUCTION

The Montana State Board of Entomology has been conducting an intensive study of certain conditions which directly or indirectly affect the question of fly control in Montana. During the season of 1914 data were collected to determine what species of flies are found in cities and towns, their comparative abundance, their seasonal abundance, what conditions favor their abundance and what general and local economic conditions must be considered in outlining control work. The detailed results are as yet unpublished. During the season of 1915 it was found advisable in continuing the work to devote considerable attention to the dispersion of the house-fly under city conditions. Miles City was selected as eminently suited for such work because of three facts; namely, the great abundance of flies, the representative size of the city and the lack of efficient control measures. The dispersion investigation and its results are discussed in this paper.

REVIEW OF PREVIOUS DISPERSION EXPERIMENTS

The importance of the radius of fly dispersion with relation to house-fly control propaganda and the spread of disease organisms by this insect has been responsible for several attempts to accumulate experimental evidence. Arnold (1907)[1] in Manchester, England, liberated 300 flies marked with a spot of white enamel and recovered five at distances of 30 to 190 yards. Copeman, Howlett and Merriam (1911)[2] conducted experiments at Postwick, England. Flies marked

with colored chalk (by shaking in a bag) and liberated at refuse accumulations about one-half mile from the village church were afterward recovered in the village. In fact they were able to recapture marked flies at 1,700 yards and found that distances of 800 to 1,000 yards were often traversed and that flies would travel 800 yards in thirty-five to forty-five minutes. Howard (1911)[3] notes experiments by Hine in which 350 flies were marked with gold enamel and recovered during three days at distances of 600 to 1,200 yards. Hine is of the opinion "that the distance flies may travel to reach dwellings is controlled by circumstances. Almost any reasonable distance may be covered by a fly *under compulsion to reach food or shelter. When these are close at hand the insect is not compelled to go far and, consequently, does not do so*" (author's italics). Experiments by Forbes were also recorded. Flies were sprayed with a chemical solution and recovered up to a distance of one-fourth mile. They were identified by another spraying with a solution which gave a blue color to those previously sprayed. Doctor Howard states that "the house-fly will seldom travel very much farther than it has to fly for food and a proper nidus for its eggs, but as a matter of fact, this is difficult to prove." Hewitt (1912)[4] conducted experiments at Ottawa during which 13,600 flies were liberated during a period of nine days. These flies were sprayed with a solution of rosolic acid. After recovery such flies when wetted with a slightly alkaline solution became scarlet. The point of liberation was near an isolation hospital on Porter's Island in the Rideau River. One hundred and seventy-four flies were observed or recovered at from 180 to 700 yards within nine days after the first release. It was found that flies "were usually collected in that portion of the district toward which the *wind had been blowing from the direction of the island, as it was found that the wind was the chief factor in determining the direction of distribution*" (author's italics). Doctor Hewitt further states that "there is no doubt that given the necessary conditions with regard to wind and elevation above the ground, the range would be considerably greater than was actually found in these experiments." Professor C. F. Hodge (1913)[5] records plagues of flies at the cribs of water works situated one and one-fourth, five and six miles respectively out in Lake Erie. He concluded that they had been carried by the wind and had gathered on the cribs as temporary resting places. These observations concerned *Stomoxys* and *Calliphora* as well as the house-fly. Hindle (1914)[6] gives the results of experiments conducted during July, August and September of 1912. Over 25,000 flies were liberated and fifty points established for their recovery. "The results of these experiments point toward the following conclusions: (1) that house-flies tend to travel either against or across the wind; this di-

rection may be directly determined by the action of the wind, or indirectly, owing to the flies being attracted by any odors it may convey from a source of food; (2) that the chief conditions favoring the dispersal of flies are fine weather and a warm temperature; the nature of the locality is another considerable factor, *as in towns flies do not travel so far as in the open country, this probably being due to the food and shelter* (author's italics) afforded by the houses; (3) that under experimental conditions, the height at which flies are liberated and also the time of day, influences the dispersal of the insects, when set free in the afternoon they do not scatter so well as when liberated in the morning; and (4) that, in the experiments made, *the usual maximum flight in localities where houses are numerous seems to be about a quarter of a mile* (author's italics), but in one case a single fly was recovered at a distance of 770 yards; it should be noted, however, that part of this distance was across fen land."*

Mr. J. Zetek (1914)[7] liberated about 5,000 flies stained with an aqueous solution of gentian violet to which a small amount of gum tragacanth had been added at an extensive manure pile 2,500 feet distant from Isthmian Canal Commission Hotel at Ancon, Panama. Seventeen flies were recovered in several screened buildings in Ancon; these were mainly *Musca domestica* Linnæus and *Hermetia illucens* (Linnæus). The writer (1914),[8] while conducting certain investigations for the Montana State Board of Entomology at Laurel, succeeded in tracing flies by placing a thick syrup colored with a red fruit extract at a privy; flies which fed on this were identified when recaptured by the red contents of the intestinal tract which showed very prominently through the ventral membrane of the abdomen. The experiment was continued but three days. Twelve flies were recovered at residences up to a distance of 150 yards and two specimens, one *Musca domestica* Linnæus and one *Fannia scalaris* Fabricius, at a meat market 300 yards distant.

The experiments as outlined above have suggested to the several investigators concerned somewhat different conclusions, both in respect to the radius of dispersion and the factors which control it. The work of Hine, Hewitt, Hindle and Parker have to do with dispersion, wholly or in part, under city or town conditions. Other observations noted concern flight across the open and under more or less rural conditions. Hewitt and Hodge are of the opinion that flies travel with the wind, while Hindle believes his work indicates that the direction of flight is against or across the wind. In partial support of the opinion of the two former writers, we have the observation of

* Quoted from Review of Applied Entomology, Vol. 2, Ser. B., Pt. 2, p. 39, Feb. 1914.

Munson (1901)[9] concerning the typhoid epidemics of 1898 that "where a strong wind constantly blows from the same direction, a fly-borne infection will extend down wind, as this insect always rises and generally moves in the direction of air currents." As is so often the case, it is probable that these two diametrically opposed opinions may be made to harmonize. Concerning flight across open country the evidence presented is entirely in favor of the view that long distance flights are common, especially up to distances of one-fourth to one-half mile and longer distances are indicated by the observations of Copeman, Howlett and Merriam and Hodge. Concerning distance of flight under town and city conditions the evidence presented seems to favor the view that where "food and shelter" are at hand dispersion is confined to within comparatively short distances of the breeding place. Such is the opinion of Hine, Howard, Hewitt and Hindle, though both Hewitt and Howard suggest the possibility of longer flights. Cox, Lewis and Glynn (1912)[10] in discussing the possibility of flies moving from one street or locality in a city to another make the statement that "our observations, however, prove that such migrations from one area to another do not occur to any extent."

The total number of flies used in these several experiments to determine the distance of dispersion would probably total less than 50,000, the work of Hindle accounting for more than one-half. All work done then, and all the conclusions are based on a fewer number of flies than would be expected to be produced during a season at any ordinary center of dispersal, such as a manure pile.

It is fully apparent that these experiments and observations leave much to be desired, especially from the standpoint of conditions in Montana. On the data at hand it can be surmised that flight across open country may be to considerable distances, but no limit of a definite nature is given, if indeed it be possible to establish such. The evidence presented concerning flight under city conditions is even less conclusive; a comparatively short radius of dispersion is indicated and statements of conclusions are more or less definitely qualified, though positive assertions, such as that of Cox, Lewis and Glynn are not lacking. Suggestions as to factors influencing or determining the radius and direction of dispersion are not few, but on the other hand, they are neither convincing nor conclusive. The experiments and results with which this paper deals concern an entire city and the liberation of nearly 400,000 marked flies. This is about eight times the total of all previous investigations combined and more than fifteen times as many as were used in the most extensive of these.

Objects of Investigation

Realizing that in Montana cities and towns, with the possible exception of a few of the larger cities, conditions are quite similar, except as regards the extent of territory covered, it was felt that investigations on dispersion conducted in a city of medium size would lead to results of general application. With this idea in mind the objects of the summer's work may be stated as general and specific, the latter referring to the special problems of the city concerned.

General Objects.—(1) To determine the distance from breeding grounds to which flies may be expected to travel under city conditions and the amount of territory over which they may spread, (2) to determine what factors control dispersion under city conditions.

Specific Objects.—(See Plate 23.) (1) To determine the radius of dispersion from the Laboratory, (2) to determine the radius of dispersion from the Miles City Sales Yards, (3) to determine the radius of dispersion from the City Dump, (4) to determine the radius of dispersion from the Washington School, (5) to determine the factors which controlled this dispersion.

These release points were dictated by local conditions and were so selected as to give an idea of the possible dispersion from breeding grounds variously located with reference to the city as a whole.

Local Conditions

As previously stated, Miles City offered unusually good opportunities for experimental work. The horse sales yards (Pl. 25, fig. 7) just west of the city, probably the largest in the world, furnished a breeding ground of great extent from which flies bred out in many millions. Many partially or entirely uncontrolled breeding places throughout the city added their quota.

The built-up portion of the city is perhaps two square miles in area and may roughly be included within a square one and one-half miles on a side. Thus the size of the city was such that it would permit the application of results to practically all Montana cities and towns and yet not too large to be covered during a season's work.

Regulations dealing with the removal of manure, etc., were in existence, but local conditions prevented their application in a way that would be effective. The City Dump to which refuse was supposed to be carried was scarcely outside the city limits.

Except along the business section of Main street the buildings are, for the most part, well separated. No section would in any way correspond to the congested areas with high buildings and narrow streets found in so many large cities.

The most closely populated portion of the city is that lying between

the Northern Pacific and the Chicago, Milwaukee & St. Paul railroads. The principal business section may be roughly included within a triangle having the Northern Pacific Railroad as its base and Fifth and Pleasant streets as its sides.

In speaking of "fly conditions" at Miles City the writer has used the word "natural." The expression "fly conditions" refers to those conditions, the variability of which affects the existence of the house fly favorably or unfavorably, *e. g.*, presence or absence of breeding materials and their availability, presence or absence of garbage and how it is cared for, etc. The term "natural" means that "fly conditions" are very favorable, both for their spread and multiplication.

Description of Release Points

Laboratory (release point number 1).—The Laboratory was situated about midway on the eastern edge of the city. Directly east there were no houses; to the northeast there were but few south of the railroad, but more beyond it to the north; to the south of the Northern Pacific tracks the houses extend eastward to some distance beyond the street on which the Laboratory was located, but are somewhat scattered; in all other directions the city was well built up. The best residential section was about one-eighth mile to the west. Figure 10 shows the Laboratory as seen from the Northern Pacific tracks with the city in the background.

Flies released at this point had been captured in several Hodge traps set on a table in the rear of the building. Flies were abundant due to garbage and manure piles near by.

Sales Yards (release point number 2).—The Sales Yards (Pl. 25, fig. 7) are located southwest of the central portion of the city and just beyond its limits. In all they cover 44½ acres of which 24½ are in pens. They are both north and south of the tracks of the Northern Pacific railroad. The houses are scattered in the vicinity of the pens to the south and the nearest of these is 300 yards from the pens to the north in which we are most interested. The latter cover nine acres and are the most productive breeding grounds. Except for a few houses in the vicinity of Station 109, the business section of the city along Fifth street (400 to 530 yards) is the portion of the city north of the railroad which is nearest the yards. It is also the most insanitary section. Between this and the release point lies the city park (Pl. 25, fig. 4) and a narrow belt of woodland along the old channel of the Tongue river. Figure 1 was taken looking toward Miles City from the west and shows the locality of the release point, while Pl. 25, fig. 2 was taken from this release point looking directly toward the city. The City Dump release point was about 800 yards north and slight-

ly west. Between it and the Sales Yards lies the old channel of the Tongue river and a considerable wooded area between the old and the present channels.

During favorable conditions flies breed out at these Sales Yards in immense numbers. The flies released here were captured for release at the point designated at Station 168. Pl. 26, fig 11 shows one of the traps in which they were captured. Flies for release at the City Dump and Washington School were also captured here in four Hodge traps.

City Dump (release point number 3).—This is located on the bank of the Tongue river at the tip of a bend in its course. It is several hundred yards west of the west central edge of the city, though there is a group of houses between First and Second streets. Otherwise the nearest section of the city is a negro settlement. Between the Dump and Second street are woods of a rather open character (Pl. 25, fig. 6). Most of the material brought to the Dump was burned, but flies were nevertheless very abundant. In order to reach the city from this point flies would have to traverse the woodland or take a roundabout course up the old Tongue river channel, though even in the latter case it would be necessary to pass through, around, or over woodland of less extent.

Washington School (release point number 4).—This school building and the grounds occupy the city block between Ninth and Tenth streets and Orr and Palmer. It is in the best residential section and quite centrally located, both with relation to the city and the other release points.

Table I Estimated Number of Living, Marked Flies in each Lot Released from each Release Point and Season's Totals

Date	Laboratory	Sales Yards	City Dump	Washington School	Date	Laboratory	Sales Yards	City Dump	Washington School
July 12	129				July 30	2,515	20,000		
13	238				31	1,958	15,000	5,000	5,000
14	997				Aug. 2	2,166	15,000	2,500	2,500
15	740				3	3,582	20,000		
16	1,353				4	2,915	20,000	5,000	5,000
17	820				5	2,892	10,000		
19	853				6	2,365	10,000	5,000	5,000
20	986	640			7	2,820	15,000		
21	1,225	3,000	3,000		9	314		5,000	2,500
22	773	10,000			10		1,000		
23	924	20,000	8,000	4,000	11	123	1,500		
24	1,366	15,000			12		15,000	5,000	5,000
26	1,531	15,000	8,000	8,000	13		1,000		
27	1,912	15,000			14		1,000		
28	2,510	20,000	8,000	8,000	16		5,000		
29	2,230	10,000							
					Totals	40,237	248,140	54,500	45,000
Total flies released									387,877

Establishment of Recapture Stations and Placing of Traps

The most satisfactory results would have been obtained if it had been possible to select a large number of stations and collect the traps at one- or two-day intervals during the whole season. Due to the requirements of other work which was carried on at the same time and insufficient assistance for a plan such as the above, the following scheme was adopted. Traps were placed in three series, those of each series at first centering about the Laboratory, Sales Yards and City Dump release points, the series being known respectively by these names. It was planned to place ten traps in each series and to collect them twice a week at alternating three- and four-day intervals. In the main this was followed, but variation from the schedule was sometimes necessary. Each series of traps was left at a given set of stations for only a few settings and then new stations were selected at constantly increasing distances. In this way it was possible to cover the whole city though some parts much more thoroughly than others. Stations of the Laboratory series were numbered from 1, those of the Sales Yards series from 101, those of the City Dump series from 201. Stores from which records were taken from sticky fly paper were assigned a station number corresponding to the locality.

With few exceptions the records are from Hodge traps placed out-of-doors. For the purposes of this work, which was to find in what localities the flies could be recaptured, the out-door results were all that were necessary and the use of traps instead of sticky fly paper permitted a larger number of flies to be captured. All in-door records are designated by reference to a foot-note. Beer and oatmeal were used as a bait for the traps.*

Method of Collecting Traps

When collecting traps the tops were removed and the hole for entrance plugged with cotton. The pans were rebaited and new tops put in place.

Method of Marking Flies

Stains Used.—Flies released from the several release points were stained as follows: Laboratory, acid fuchsin; Sales Yards, rosolic acid; City Dump, aqueous eosin; Washington School, trypanblau. Those released from the Sales Yards on August 5, 6 and 7, were stained with methylene green; this was done with the hope that by subsequent recaptures some idea could be obtained of the average life of the house-fly. The results were unsatisfactory, however.

Preparation of Stains.—Stains were prepared as follows: Acid fuchsin, 4 c.c., 10 per cent alcohol, 100 c.c.; rosolic acid, 4 c.c. dissolved

* In the work during 1914 it was found that beer and oatmeal were two to three efficient as beer alone and afforded a standard bait.

in 20 c.c. of 95 per cent alcohol and added to 180 c.c. of water; aqueous eosin, 4 c.c., water, 100 c.c.; trypanblau, 4 c.c., water, 100 c.c.; methylene green, 4 c.c., water, 100 c.c.

In preparing the rosolic acid solution it was found necessary to dissolve the crystals in 95 per cent alcohol and then add this solution to the water. The trypanblau used was old and but very slightly soluble in alcohol.

USE OF STAINS.—The stains were applied to the flies while in the traps by means of separate small glass atomizers, except that the Sales Yards flies captured in a larger trap were stained with spray from a large tin atomizer. The stain in all cases was applied at the point of release so that stained flies were never transported from one point to another.

METHODS OF KILLING AND DIFFERENTIATING FLIES

As soon as traps were brought into the laboratory each was placed in a five-pound lard pail and the flies killed by ether, which was found to be more satisfactory than chloroform.

For examination the flies were spread in a thin layer on a newspaper and were first sprayed with 50 per cent alcohol. Fuchsin, eosin and methylene green entered into solution and left a spot under each fly marked with these stains. The number of stained specimens was immediately recorded and the flies again sprayed with a weak alkaline solution (Na O H). Flies stained with rosolic acid became a bright scarlet and left a corresponding spot on the paper while trypanblau left a blue spot.

It sometimes happened that there was uncertainty regarding the color left on the paper, except, of course, when the mark was blue or green. The other stains were then differentiated by the following tests. The fly responsible for the spot in question was placed in a very small homeopathic vial and about ½ c.c. of 50 per cent alcohol added. If the stain was eosin the yellowish tint imparted to the solute was a distinct proof. Sometimes the amount of stain was so small that the tint was scarcely perceptible. In this case a small amount of the alkaline solution was added; if fuchsin was present the color disappeared, if eosin it remained constant, and if rosolic acid it became greatly intensified. If these tests were not decisive no record was kept. The process was repeated with the flies from each station.*

* At the end of the season a trap was examined which had been in place for a month at the Sales Yards. It was found that flies marked with rosolic acid yielded a yellowish brown color when sprayed with the alcohol solution. Possibly the acid underwent some chemical change during its long exposure to the air, but the scarlet color afterwards appeared when sprayed with the Na O H, but much fainter than normal. The records from this trap are not given.

In discussing previous experiments reference was made to a method utilized by the writer by which flies were allowed to mark themselves by feeding on colored sugar syrup. Such flies were afterwards identified by the colored contents of the alimentary tract which showed through the thin ventral membrane. When flies were sprayed at the Laboratory the stain was applied with the bait pan attached. The bait became highly colored with the fuchsin and flies fed on it both while it was in the pan and after it was dumped. During the summer it was noted that the majority of flies on the Laboratory windows showed that they had visited this colored bait. Such flies were also frequently recovered in traps. Several times the abdominal contents of flies from some of the traps placed in the Laboratory series were squeezed out and ten to twenty flies would be found which had apparently fed on the colored bait, though many times not enough had been eaten so that the color showed through. This color usually responded to the test for fuchsin given above. This was incidental to the actual experimental work and no records of such flies appear. Their number, however, always exceeded that of flies which had been stained externally. This method of marking flies has obvious disadvantages and was first used as a makeshift for lack of other means, but it does suggest a practical means of demonstrating the filth-to-food habit of flies. By placing colored bait at a privy or garbage accumulation any person can readily satisfy himself in this respect as the stained abdomens show up quite brilliantly when flies are seen on the windows.

The advisability of spraying stained flies with some solvent or intensifier of the stain used is a point worth emphasizing. At first flies were examined before spraying, but this was not only tedious, but a useless expenditure of time. Stained specimens could only occasionally be detected whereas catches which yielded no results by this method were sometimes found to contain ten, twenty or even forty marked flies.

Summary of Data

Laboratory Series

First lot of flies released, July 12.
Last lot of flies released, August 11.
Number of lots released, 26.
Total number of flies released, 40,237.
Total *Musca domestica* released, 35,270.
Number of laboratory flies recaptured, 242.*
Number of stations at which recaptured, 45.

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* *Musca domestica*, 234; *Phormia regina*, 2; *Muscina stabulans*, 6.

Longest distance at which recaptured within city limits, 1,966 yards.
Recaptured 700 yards beyond city limits on same side of city.

Sales Yards Series

First lot of flies released, July 20.
Last lot of flies released, August 16.
Number of lots released, 23.
Total number of flies released, 248,140.
Number of Sales Yards flies recaptured, 667.
Number of stations at which recaptured, 62.
Longest distance at which recaptured within city limits, 2,200 yards.
Longest distance at which recaptured, 3,070 yards (this was 700 yards beyond city limits on opposite side of city).

City Dump Series

First lot of flies released, July 21.
Last lot of flies released, August 12.
Number of lots released, 10.
Total number of flies released, 54,500.
Number of City Dump Flies recaptured, 69.
Number of stations at which recaptured, 20.
Longest distance at which recaptured within city limits, 2,333 yards.
Longest distance at which recaptured, 3,500 yards (nearly 2 miles). This was 700 yards beyond city limits on opposite side of city.

Washington School Series

First lot of flies released, July 23.
Last lot of flies released, August 12.
Number of lots released, 9.
Total number of flies released, 45,000.
Number of Washington School flies recaptured, 78.
Number of stations at which recaptured, 20.
Longest distance at which recaptured within city limits, 1,230 yards.
Longest distance at which recaptured, 2,000 yards (this was 700 yards beyond city limits).

This station was centrally located within the city, hence recaptures within city limits could not be at such great distances as from the other release points.

COMBINED DATA FOR ALL RELEASE POINTS

First flies released, July 12.
Last flies released, August 16.
Total duration of experiment, 39 days.
Total lots of flies released, 68.

Total number of flies released, 387,877.
Total number of flies recaptured, 1,056.
Total number of stations used, 91.
Total number of stations at which flies were recaptured, 78.
(Traps were not recovered from 8 stations, hence liberated flies were recaptured at 78 stations from a total of 83 from which flies were examined).
Combined total of days during which traps were placed, 680.
Longest distance at which flies were recaptured within city limits, 2,333 yards.
Longest distance at which flies were recaptured, 3,500 yards (nearly 2 miles).

Stations at which flies were recovered from 1 release point only: 2, 3, 4, 5, 7, 8, 9, 10 (these traps were moved before it was possible to make recaptures, except from Laboratory release point), 12, 17, 24, 25, 34, 35, 36, 37, 101, 103, 110, 111, 112, 113, 120, 122, 124, 128, 129, 212, 213, 223, 241, 242, total 32.

Stations at which flies were recovered from 2 release points: 104, 107, 115, 1, 15, 19, 20, 21, 26, 28, 29, 30, 32, 38, 59, 64, 204, 205, 209, 215, 217, 218, 219, 222, 239, 240, total 26.

Stations at which flies were recovered from 3 release points: 11, 18, 31, 33, 105, 109, 117, 118, 119, 121, 127, 165, 208, 211, 214, 220, total 16.

Stations at which flies were recovered from 4 release points: 62, 168, 216, 224, total 4.

Possibilities of Error

The methods used in counting and releasing show several possibilities of error. What would at first sight seem a most potent source was the fact that flies for release at the City Dump and Washington School were captured at the Sales Yards about a hundred yards from the Sales Yards release point and the possibility of capturing flies stained with rosolic acid and afterwards releasing them again at the two points mentioned is at once apparent. When the facts are considered, however, the danger of thus affecting the results becomes less obvious. Table II shows that out of 150,000 flies captured in a trap placed at the Sales Yards during two weeks (July 31 to August 13) only 197 Sales Yards flies were recaptured; that is, approximately one for every 750 released. The smaller Hodge traps were placed near this large one and it is fair to assume that they recaptured stained Sales Yards flies in the same ratio. Hence, since such flies were released at the City Dump and Washington School there would have been approximately 133 Sales Yards flies released at these two points.

TABLE II. LOCALITY OF RECAPTURE STATIONS; NUMBER OF MARKED FLIES RECAPTURED AT EACH STATION DURING EACH SETTING; NUMBER OF DAYS TRAPS WERE IN PLACE; DISTANCE IN YARDS FROM VARIOUS POINTS OF RELEASE

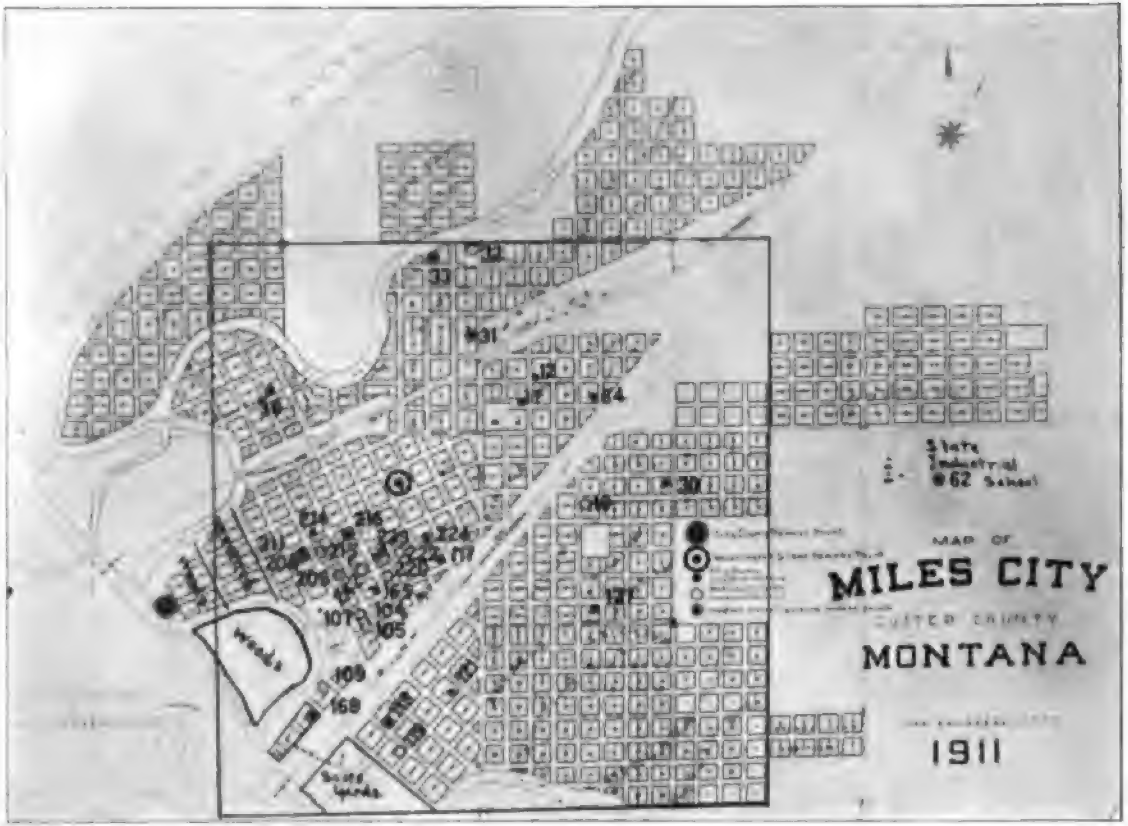
(L.=Laboratory, S. Y.=Sales Yards, C. D.=City Dump, W. S.=Washington School)

Date	Location of Stations and Station Numbers	Number of Stained Flies Recaptured	Release Point	Number of Days	Distance of Dispersion in Yards
July 13	(1) 506 N. Lake[d]	1	L.	1	130
July 14	(2) 605 N. Lake	1	L.	2	100
	(10) 620 N. Lake	3	L.	2	100
July 15	(5) 710 N. Lake	1	L.	1	150
	(8) 610 N. Cottage Grove	1	L.	1	160
	(10) 620 N. Lake	1	L.	1	100
July 16	(2) 606 N. Lake	3	L.	1	100
	(3) 602 N. Lake	10[a]	L.	1	50
	(4) 707 N. Lake	2[b]	L.	1	160
	(10) 620 N. Lake	2[c]	L.	1	100
July 17	(1) 506 N. Lake[d]	1	L.	1	100
	(3) 602 N. Lake	7	L.	1	50
	(9) 714 N. Cottage Grove	1	L.	1	240
	(7) 1611 Phillips	1	L.	1	240
July 20	(8) 610 N. Cottage Grove	2	L.	3	160
	(9) 714 N. Cottage Grove	3	L.	3	240
	(10) 620 N. Lake	1	L.	3	100
July 23	(101) Alley, 6th to 7th	1	S.Y.	3	660
	(103) Alley, 5th to 6th	1	S.Y.	3	600
July 25	(64) 607 N. Custer (L.)[e]	1	C.D.		2,135
July 26	(12) 1605 Gordon	1	C.D.	4	1,966
	(18) 110 N. Center	1	L.	5	500
	(19) 200 N. Jordan	19[a]	L.	5	500
July 27	(101) Alley, 6th to 7th	6	S.Y.	4	660
	(109) House near Sales Yards	2	S.Y.	4	200
		1	C.D.	4	800
July 28	(208) 115 N. 5th	3	S.Y.	4	660
	(209) 119 N. 5th	1	S.Y.	4	660
	(211) 123 N. 5th	1	S.Y.	4	700
		4	S.Y.	4	800
	(214) 511 Palmer	1	C.D.	4	760
		1	L.	4	1,400
July 29	(11) 613 N. Center	2	L.	3	330
		1	C.D.	3	500
	(15) 204 N. Lake	1	L.	3	500
July 30	(107) Hotel, 6th	1	S.Y.	3	500
	(109) House near Sales Yards	3	S.Y.	3	200
	(110) Cafe, 18 S. 6th	5	S.Y.	3	600
	(111) Hotel, 22 S. 6th	11	S.Y.	3	600
July 31	(204) Alley, 5th to 6th	4	S.Y.	3	600
	(205) Alley, 5th to 6th	1	S.Y.	3	630
	(214) 511 Palmer	3	S.Y.	3	800
	(216) 117 N. 7th	1	S.Y.	3	830
Aug. 1	(168) Sales Yards	1[e]	W.S.		1,130
Aug. 2	(1) 506 N. Lake[d]	12	L.	4	130
	(11) 613 N. Center	1	L.	4	330
	(20) 715 N. Jordan	5	L.	4	200
Aug. 3	(103) Alley, 5th to 6th	6	S.Y.	4	600
	(104) Alley, 5th to 6th	8	S.Y.	4	533
		3	W.S.	4	600
	(105) Cafe, 6th	6	S.Y.	4	530
	(107) Hotel, 6th	42	S.Y.	4	500
		6	W.S.	4	630
	(109) House near Sales Yards	42	S.Y.	4	[illegible]
		6	W.S.	4	[illegible]
	(111) Hotel, 22 S. 6th	9	S.Y.	4	600
Aug. 4	(204) Alley, 5th to 6th	14	S.Y.	4	600
		2	L.	4	600
	(205) Alley, 5th to 6th	2	S.Y.	4	630
	(208) 115 N. 5th	6	S.Y.	4	660
		1	L.	4	1,500
		2	C.D.	4	660
	(209) 119 N. 5th	1	S.Y.	4	660
	(211) 123 N. 5th	3	S.Y.	4	700
		3	L.	4	1,500
		1	C.D.	4	660
	(213) 508 Palmer	3	S.Y.	4	730
	(214) 511 Palmer	1	S.Y.	4	800
		1	L.	4	1,400
	(212) 122 N. 5th	3	S.Y.	4	730
	(216) 117 N. 7th	14	S.Y.	4	830
		1	L.	4	1,360
Aug. 5	(1) 506 N. Lake	4	S.Y.	3	1,830
		9	L.	3	130
	(11) 613 N. Center	1	S.Y.	3	1,730
		2	L.	3	330
	(15) 204 N. Lake	3	S.Y.	3	1,700
		2[f]	L.	3	500
	(17) 20 N. Lake	3	S.Y.	3	1,600
		2	S.Y.	3	1,730
	(18) 110 N. Custer	1	L.	3	500
		6	W.S.	3	930
	(19) 200 N. Jordan	3	S.Y.	3	1,860
		8	L.	3	500
	(21) 805 N. Jordan	2	S.Y.	3	2,200
		5	L.	3	266
		9	S.Y.	3	530
Aug. 6	(105) Cafe, 6th	1	L.	3	1,430
		3	W.S.	3	630
	(112) Alley, 7th to 8th	3	S.Y.	3	730
	(113) Alley, 7th to 8th	2	S.Y.	3	760
	(115) Alley, 8th to 9th	3	S.Y.	3	1,130
		1	L.	3	1,130
	(117) Market, Main St.	2	S.Y.	3	930
		1	L.	3	1,000
		1	C.D.	3	1,260
	(59) Grocery, 8th	3	S.Y.	1	1,100
		4	L.	1	1,100
Aug. 7	(205) Alley, 5th to 6th	2	S.Y.	3	630
		2	W.S.	3	400
	(209) 119 N. 5th	4	S.Y.	3	660
		3	L.	3	1,500
	(211) 123 N. 5th	3	L.	3	1,500
	(213) 508 Palmer	2	S.Y.	3	730
		1[g]	S.Y.	3	730
	(214) 511 Palmer	3	S.Y.	3	900
		7	L.	3	1,400
	(215) 112 N. 5th	1	L.	3	1,430
		1	W.S.	3	560
		14	S.Y.	3	830
	(216) 117 N. 7th	12[g]	S.Y.	3	830
		12	L.	3	1,360
		16	W.S.	3	300
Aug. 9	(24) 717 Prairie	1	S.Y.	3	1,800
	(25) 718 Prairie	1	S.Y.	3	1,830
	(26) County Hospital	1	S.Y.	3	2,000
		1[g]	S.Y.	3	2,000
		4	L.	3	366

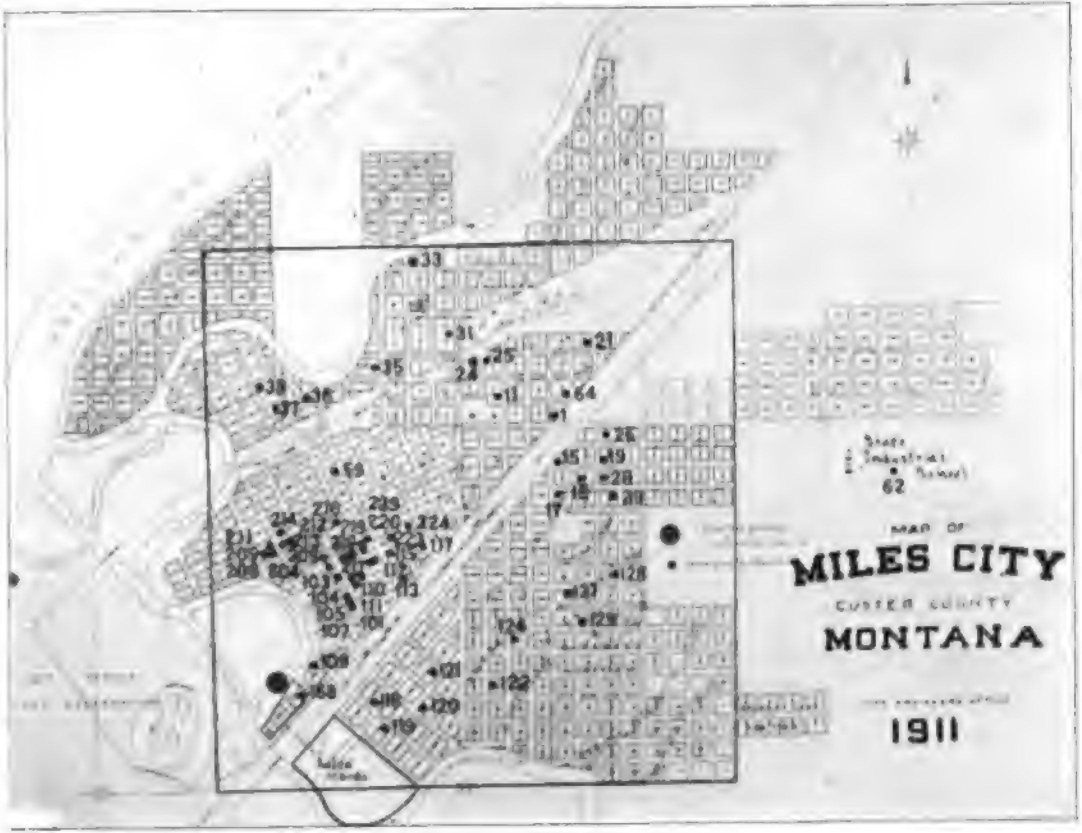
TABLE II—*Concluded*

Date	Location of Stations and Station Numbers	Number of Stained Flies Recaptured	Release Point	Number of Days	Distance of Dispersion in Yards
	(28) 106 N. Jordan	1[m]	S.Y.	3	1,830
		2[h]	L.	3	433
	(29) 19 N. Merriam	5	S.Y.	3	1,830
		3[m]	S.Y.	3	1,830
		1	L.	3	583
	(30) 119 N. Strevell	1	C.D.	3	2,333
		2	L.	3	500
Aug. 10	(105) Cafe, 6th	7	S.Y.	4	530
		1	S.Y.	4	460
	(118) 501 Yellowstone	1[m]	S.Y.	4	460
		3	C.D.	4	1,130
		1	W.S.	4	1,100
		5	S.Y.	4	560
	(119) 415 Missouri	1[m]	S.Y.	4	560
		2	L.	4	1,830
		2	W.S.	4	1,230
	(120) 604 Missouri	1	S.Y.	4	700
		2[m]	S.Y.	4	700
	(121) 717 Missouri	3	S.Y.	4	730
		3	L.	4	1,500
	(124) 510 S. Center	2	S.Y.	4	1,130
		1[m]	S.Y.	4	1,130
Aug. 11	(217) Alley, 6th to 7th	1	S.Y.	4	660
		1	L.	4	1,830
	(218) Alley, 6th to 7th	1	S.Y.	4	700
		1	L.	4	1,300
	(219) Alley, 6th to 7th	2	S.Y.	4	700
		4	L.	4	1,300
	(220) Alley, 7th to 8th	4	S.Y.	4	760
		1	L.	4	1,230
		2	W.S.	4	400
	(222) Alley, 8th to 9th	1	L.	4	1,130
		1	W.S.	4	300
	(223) Alley, 8th to 9th	3	S.Y.	4	900
		2	S.Y.	4	960
	(224) Alley, 9th to 10th	4[m]	S.Y.	4	960
		6	L.	4	1,000
		1	C.D.	4	1,300
		1	W.S.	4	260
Aug. 12	(118) 501 Yellowstone	1	S.Y.	2	460
	(119) 415 Missouri	1	L.	3	1,830
	(120) 604 Missouri	1	S.Y.	3	700
	(121) 717 Missouri	1	S.Y.	2	730
		1	C.D.	2	1,360
	(122) 710 S. Prairie	1	S.Y.	3	1,030
	(124) 510 S. Center	3	S.Y.	3	1,130
		7	S.Y.	3	830
	(216) 117 N. 7th	6	L.	3	1,260
		2	C.D.	2	900
		1[m]	S.Y.	3	830
	(31) 811 N. Montana	8	S.Y.	2	1,830
	(32) 1101 N. Montana	1	W.S.	2	1,100
	(33) 1116 N. Garland	2	S.Y.	3	2,100
	(36) 723 Phillips	1	S.Y.	2	1,360
	(37) 707 N. 7th	4	S.Y.	2	1,330
	(38) 600 Hubble	5	S.Y.	2	1,400
		1	CD	2	1,100
Aug. 13	(240) 801 Main St.[g]	2	S.Y.	?	1,130
		2	L.	?	1,130
	(241) 823 Main St.[g]	1	S.Y.	?	900
		1[m]	S.Y.	?	900
	(165) 720 Main St.[g]	4	S.Y.	?	1,200
		1	W.S.	?	370
		3	L	?	1,500
	(31) 811 Montana	4	S.Y.	2	1,830
		2	C.D.	2	1,830
		1	W.S.	2	700
	(32) 1101 Montana	1	L.	2	1,100
		4	S.Y.	2	2,100
	(33) 1116 Garland	10	C.D.	2	1,966
		8	W.S.	2	1,000
	(34) 1001 Woodberry	1	L.	2	1,033
	(35) 707 Woodberry	1	S.Y.	2	1,560
	(38) 600 Hubble	3	S.Y.	2	1,406
		1	C.D.	2	1,100
		4	S.Y.	2	1,430
	(127) 301 S. Custer	1[m]	S.Y.	2	1,430
		3	C.D.	2	1,930
	(128) 215 S. Merriam	1	S.Y.	2	1,760
		23	S.Y.	2	830
		2[m]	S.Y.	2	830
	(216) 117 N. 7th	6	L.	2	1,260
		12	C.D.	2	900
		2	W.S.	2	300
	(168) Sales Yards	28	L.	14	1,966
		16	C.D.	14	800
		5	W.S.	14	1,130
		197	S.Y.	14	109
Aug. 15	(64) 607 N. Custer	2	S.Y.	1	1,966
Aug. 17	(127) 301 S. Custer	1	S.Y.	2	1,430
		1	L.	2	930
Aug. 18	(64) 607 N. Custer	4	S.Y.	1	1,966
Aug. 19	(242) Main St.[g]	1	W.S.	?	460
	(239) Main St.[g]	1	S.Y.	?	765
		1	C.D.	?	840
	(234) Main St.[g]	1	L.	?	1,060
	(129) 412 S. Custer	1	S.Y.	5	1,460
	(216) 117 N. 7th	1	L.	5	1,360
	(168) Sales Yards	6	S.Y.	3	160
		9	L.	3	1,966
		1	C.D.	3	860
		29	S.Y.	11	3,670
Aug. 20	(63) State Industrial School	2	L.	11	1,430
		5	C.D.	11	3,500
		4	W.S.	11	2,000
Aug. 21	(168) Sales Yards	1	L.	5	1,966
		4	W.S.	5	1,130
	Totals	1,066			

[a] Musca domestica, 8; Muscina stabulans, 2.
[b] Musca domestica, 1; Phormia regina, 1.
[c] Musca domestica, 1; Phormia regina, 1.
[d] Trap set inside.
[e] Musca domestica, 17; Muscina stabulans, 2.
[f] Musca domestica, 1; Muscina stabulans, 1.
[g] Record from sticky fly paper exposed inside.
[h] Musca domestica, 1; Muscina stabulans, 1.
[m] Methylene green.
[n] This fly was captured on a laboratory window and the chance that it may have been brought back on the clothes of the person releasing the flies is not improbable.
[o] Observed.



Stations at which Laboratory Flies were Recaptured
(Heavy lines enclose all built-up sections of city)



Stations at which Sales Yards Flies were Recaptured
Heavy lines enclose all built-up sections of city)

But since the season totals show that only one of every 366.5 flies stained was recovered the possibility of error becomes insignificant. Furthermore, such flies would have been stained twice and if captured their color reactions would probably not have been normal and such records would have been disregarded.

Another source of error was the fact that the number of flies released was estimated in all cases. At the Laboratory the number of each species was estimated and these figures are perhaps the nearest correct. The Sales Yards figures are small, rather than large, but the numbers in the City Dump and Washington School series are likely to have been overestimated. The flies from these traps were released at successive intervals of two, two and three days. They were usually well filled and many flies must have died because of their long captivity in such close quarters. This fact was considered when estimates were made, but the writer feels that the latter, nevertheless, were too high.*

The possibility of carrying stained flies on clothing was guarded against by careful examination before leaving the various release points.

Concerning Factors of Dispersion

The following factors have been suggested by previous writers as concerned in fly dispersion: wind, temperature, state of weather, nature of locality, height at which flies are liberated and the time of day at which liberated. When we consider that dispersion concerns the sum total of flies migrating from a breeding ground during the breeding season, these terms seem to have less significance than may be the case when dealing with short periods of time. The writer prefers to consider seasonal dispersion as the combined result of tropisms, or responses to stimuli, which are active during the whole season, but vary in intensity and duration. Observations of short duration may be of value to demonstrate the dominance of some one stimulus for a short time, but from the standpoint of seasonal results this stimulus may be reduced to a point of insignificance. For instance, a certain stimulus (wind, for example) may cause flies to migrate in one direction on one day, in another the next and so on, but when the results are examined in toto for the experiment in its whole duration it is found that flies are more or less equally distributed in all directions which would presumably have been the case if this stimulus had never existed. This factor or stimulus, then, can be eliminated as having any more than an incidental effect on the ultimate distribution.

* During the season of 1914 the writer and his assistant counted large numbers of flies in Hodge traps and became accustomed to estimating the numbers of flies contained.

That is, on the basis of averages, the counterbalancing effects of certain stimuli will incidentally balance each other if long enough periods are considered.

For the purposes of discussion those so-called factors of dispersion which are themselves stimuli or the sources of stimuli may be separated into three divisions—physical, physiographical and physiological.*

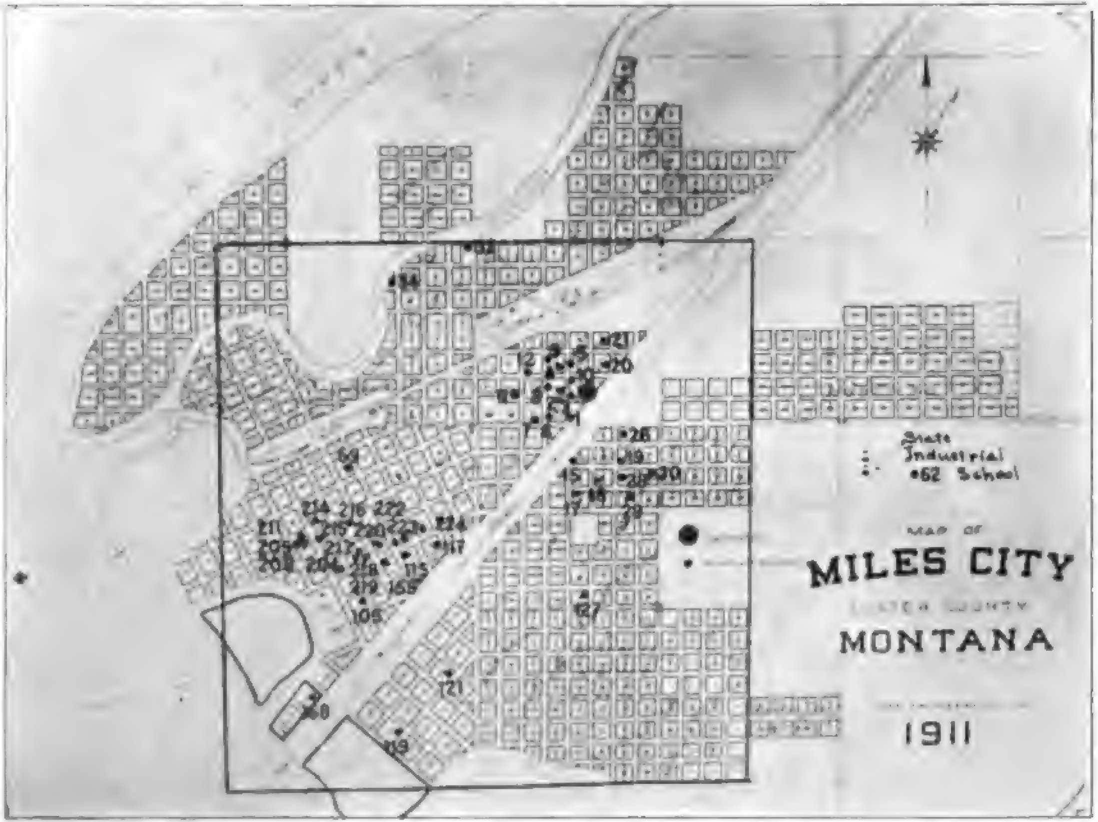
Physical

WIND.—As previously noted, Hewitt has suggested that flies will travel with the wind (negative anemotropism), while Hindle claims that they fly against or across the wind (positive anemotropism). From an unbiased standpoint both statements seem reasonable, given the proper conditions. Hewitt's observations would indicate that, under certain conditions, flies are stimulated to fly with the wind, but was not this stimulus dominant because others were comparatively less intense? In the case of Hindle's observations, the reaction of the flies was positively anemotropic in result, but the stimulus may have been due to odors borne by the wind so that the actual reaction was really chemotropic, the wind acting as an agent to convey the stimulus.

In conducting the summer's work an attempt was made to determine to just what extent, under city conditions, wind served as a stimulus to migratory movement. Careful examination of data has failed to give proof of a positive character. For illustration let us examine the data of Tables III and IV. The former is a record of stained flies recovered at Station 216 during a period of twenty days from July 30 to August 19. A total of 132 such flies were captured, seventy-four from the Sales Yards, twenty-six from the Laboratory, eighteen from the Washington School and fourteen from the City Dump. During the same period Table IV shows that the wind varied from north to south through east, the majority of the records reading north, northeast or east.

Station 216 is about centrally located with the Laboratory and Washington School release points to the east and the City Dump and Sales Yards release points to the west (See Plate 23). The wind, then, as far as records show, blew from the direction of the Laboratory and Washington School toward this station and the other release points beyond for a considerable part of the period in question, but never from the opposite direction. Considering Sales Yards versus Laboratory flies, we find that 248,140 flies were released from the Sales Yards

* This division is not exact. It might be better if vital were substituted for physiologic[illegible] [illegible]nuli herein referred to as physiological arise from sources vital to fly [illegible] feeding areas and breeding areas.



Stations at which City Dump and Washington School Flies were Recaptured
(Heavy lines enclose all built-up sections of city)

Showing Recapture Station 216 and the Release Points

TABLE III. RECORD OF RECAPTURE STATION 216

Dates	Total stained flies Recovered	Number of flies from Laboratory, 1,260 yards	Number of flies from Sales Yards, 830 yards	Number of flies from City Dump, 900 yards	Number of flies from Washington School, 300 yards
July 30–July 31	1		1		
July 31–Aug. 4	15	1	14		
Aug. 4–Aug. 7	54	12	26		16
Aug. 7–Aug. 12	16	6	8	2	
Aug. 12–Aug. 14	45	6	25	12	2
Aug. 14–Aug. 19	1	1			
Totals	132	26	74	14	18

TABLE IV. MILES CITY METEOROLOGICAL DATA: DIRECTION AND VELOCITY OF WIND; PRECIPITATION; TEMPERATURE (JULY 12 TO AUGUST 20)*†‡

Date	Wind direction 6 A. M.	Wind direction 6 P. M.	Wind velocity Miles per hour (av'rage)	Precipitation Inches T = trace	Temperature Maximum and minimum
July 12	W.	N.	4	0	84 60
13	W.	N.	7	0	82 60
14	N.E.	N.	5	0	80 60
15	W.	M.	6	.14	73 59
16	S.	E.	3	1 02	82 54
17	E.	N.	6	.12	72 56
18	W.	N.	6	0	64 54
19	S.E.	N.E.	3	T	72 45
20	N.	N.	3	0	79 50
21	S.	S.E.	3	75	84 54
22	S.	N.E.	3	.17	92 60
23	S.W.	N.	5	0	93 62
24	W.	N.	6	0	78 58
25	N.E.	E.	6	.50	80 58
26	N.	N.	5	0	77 58
27	N.E.	E.	4	0	78 56
28	E.	S.W.	4	0	84 61
29	S.W.	S.E.	3	0	85 58
30	N.	E.	3	0	81 57
31	N.E.	N.E.	3	0	83 58
Aug. 1	N.	N.	6	0	68 58
2	N.	S.E.	4	0	75 55
3	E.	E.	8	0	82 56
4	E.	E.	4	0	92 63
5	E.	E.	4	0	92 65
6	N.	E.	4	0	88 62
7	S E	N.E	4	0	90 62
8	S E.	S E	5	0	90 63
9	S E	N.E	3	0	91 66
10	S.	E.	2	0	92 62
11	N.E	E.	6	04	92 60
12	N.	N.E	3	0	90 60
13	S.	N E.	3	0	86 61
14	N.E.	N.E.	4	0	90 60
15	N E	N E.	4	14	90 66
16	S E.	E	6	1 02	90 63
17	S E	N E	6	12	91 60
18	S E	N E	3	0	88 64
19	N E	N E	4	T	88 63
20	W.	N E	4	0	82 62

* The writer is indebted to the United States Weather Bureau for the data in this table. It is not the data which would be the most significant in all cases but the best available.

† The writer is also indebted to the Weather Bureau for the following data which show the average hourly wind velocity (miles per hour) at Miles City and at several of the large cities in the east during the months of June, July and August respectively Miles City, Mont., 6, 54; Boston, Mass., 9, 8, 9, New York, N. Y., 13, 12, 14; Philadelphia, Pa., 10, 8, 9; Atlantic City, N. J., 9, 7, 8; Washington, D. C., 6, 5, 5

‡ These records were taken at 6 00 a. m. and 6 00 p. m. hence, there is a possibility that midday records might be different.

(1,260 yards from the station) and 40,237 from the Laboratory (830 yards from the station). Do not the respective totals of seventy-four and twenty-six flies recovered from these release points bear a more direct relation to the comparative distances and numbers released than to any consideration of wind direction or wind velocity that can be deduced? A similar review of the data concerning the other two release points gives no essentially different results. This seems to indicate, then, that as a stimulus having any effect on ultimate dispersion in a given direction from a breeding area when a long period of time is concerned, wind may be a negative factor, and in this particular citation there is no evidence to demonstrate any influence of wind as a stimulus when the shorter periods of time concerned are considered.

If Hindle's idea of dispersion against and across the wind has a true significance in the economy of fly dispersion, it would seem capable of interpretation in the following way. Without the assistance of air currents, odors originating at any given point have the ability to diffuse through the atmosphere and within a certain radius would logically be sufficiently concentrated to serve as a positive chemotropic stimulus. A point must eventually be reached, however, at which the diffusion is so great that all power of stimulation is lost.

It may well be that a light breeze will serve to so strengthen the odor beyond this point so that the power of stimulation will extend beyond its normal radius. In the opposite direction the distance of possible stimulation would be decreased or reduced to nothing. Yet, in this case the wind serves rather to increase the distance to which an already active factor is at work in a certain direction than to act as a factor itself, unless it be that it exerts a stereotropic influence.

Another point still further complicates the discussion. Flies have been repeatedly referred to in literature as seeking "shelter." Certain it is that when meteorological conditions are unfavorable they are little in evidence. This suggests that if the wind be too strong flies may seek protection.

Although the data of the present investigations indicate that wind, as a seasonal factor, may have had little significance, it is by no means proved that this would be so under all conditions. Munson (1901),[9] concerning the typhoid epidemics of 1898, says that "when a strong wind constantly blows from the same direction, a fly-borne infection will extend down the wind."

Rain.—Flies are not active during inclement weather, hence dispersion is temporarily affected because of lessened activity.

Temperature.—The same consideration applies to low temperatures. Optimum temperatures, on the other hand, increase activity,

favoring both more rapid breeding and greater distribution. It may justly be considered a seasonal factor, its influence being present at all times, either in a positive or a negative manner

Physiographical

Elevations and Depressions.—Zetek, in discussing his experiments at Ancon, Panama, expressed his belief that flies follow depressions, rather than to cross elevations. How much importance is to be attached to this point when considering dispersion under city conditions is not entirely apparent. It may have some significance when considering congested areas and high buildings which offer parallel conditions on a small scale. Whatever stimulus might prompt flies to follow a depression in natural topography, other additional stimuli would be active in a city (presence of food, etc.).

Bodies of Water.—Hewitt's experiment at Ottawa demonstrated that streams passing through a city are not a barrier to fly dispersion and Hodge's observations at Lake Erie indicate that considerable bodies of water may be crossed.

Wooded Areas.—The summer's results indicate that wooded areas of small extent and of an open character are not an obstacle to the spread of flies. In order to reach the city from the City Dump release point it was necessary to traverse a wooded area 200 yards in width or to take a roundabout course up the old channel of the Tongue river, shown on the map. In the latter case it was necessary to pass through woodland, but of less extent. City Dump flies captured at the Sales Yards, 800 yards distant, may have followed up the Tongue river, have passed through or over almost continuous woods in the most direct line or have taken a more devious course by way of the city itself.

Physiological

To live and reproduce are functions of all animal life, both essential to the perpetuation of the species, but the second highly dependent on the first. As entomologists we are acquainted with many obvious instances where adult life is entirely devoted to feeding and reproduction, and if there are any two facts that are always in evidence concerning the house-fly they are its presence at feeding and breeding grounds. These facts, then, indicate the two factors of prime importance which, given normal conditions, seem to be largely responsible for the migratory movements of the house-fly under city conditions—namely the stimuli from feeding areas and the stimuli from breeding areas. These apparently are chemotropic and to them the fly seems to react positively to a far greater extent than to any other stimuli which cause movement, though it is obvious that various

physical stimuli may acquire incidental or temporary dominance, but would have little effect on seasonal distribution. Isolated cities or localities, however, are of undoubted occurrence, where some one physical factor might exert its stimulus continuously for a long period or even a whole season and hence become one of major importance (Munson, l. c.).

In poorly kept cities flies are quite generally distributed, but there are usually areas of unusual abundance due to their advantages as good feeding and breeding grounds. Such areas may be large as a poorly cared for market district or a breeding ground of many acres such as the Miles City Sales Yards, and they may be small as in the vicinity of poorly kept residences or stables. To show how such areas exert a stimulus influencing migration, let us consider Station 216 again. The house, a boarding place, was very clean, but a manure pile, privy with open door and uncovered seats, several accumulations of garbage and a privy with an open vault in the next yard (Pl. 26, figs. 8 and 9) were efficient attractions and because of these, flies were abundant in the vicinity of the house. At this station (at the backdoor of the house) 132 stained flies were recovered in twenty days. The total number of days represented in the whole experiment was 680, yet in twenty (one-thirty-fourth of whole time) this station attracted one-eighth the total catch.

The State Industrial School, which is 700 yards east of the outside limits of Miles City, is another example. Flies were very abundant, especially at the pig house 150 yards to the east and at a shack for mixing garbage for the pigs nearer the main buildings. The pig house was 3,500 yards from the City Dump, 3,070 from the Sales Yards, 2,000 from the Washington School and 1,430 from the Labotory. On August 9, nine traps were placed, two inside the pig house, one at the garbage shack and the others at the barns, poultry houses, etc. The traps were collected on the 20th of August and twenty-nine Sales Yard, four Washington School, five City Dump and two Laboratory flies recaptured. Except for a few in the trap at the garbage shack, all were recaptured at the pig house about which flies were breeding in stupendous numbers. These flies had not only crossed Miles City, but the 700 yards of open country intervening and for the most part had selected the pig house as their goal. The isolated location of the school doubtless rendered the apparent attracting stimulus from the pig house doubly effective, while the flies about the main buildings were perhaps migrants from this breeding ground.

In presenting these illustrations the object is to show that the fly is essentially a migratory insect, the migration, in the main, seeming to depend upon the two stimuli under discussion, and also that it is

a false idea to assume that when flies breed out near "food and shelter" they necessarily do not migrate far. Let us further illustrate. It is known that the house-fly deposits several batches of eggs at several intervals. Yet, in general, feeding areas are not breeding areas; large districts suitable for feeding may lack breeding facilities. Hence, must not the fly continually migrate from one to the other? That it does so is evidenced by the fact that 85 to 95 per cent are conceded to breed out in horse manure, yet we do not find that percentage of the adults normally in its vicinity. This indicates that the stimulus from breeding areas may at times transcend that from feeding areas and vice versa impelling consequent migrations. Hutchinson (1915)[11] presents evidence along this line. Recently emerged flies were marked and liberated at a dairy barn about 700 yards distant from a stable and a kitchen. Of two of the lots liberated flies were recovered at the kitchen, but none at the stable.

Another observation from the summer's work may well be noted. The Miles City Sales Yards afforded extensive breeding facilities. As long as certain physical factors permitted breeding, flies were always present in enormous numbers, but during several periods factors which will be dealt with in another paper practically eliminated breeding, though manure was as abundant as ever. Immediately the number of flies began to decrease, simply due to migration without any compensating emergence of adults.

The House-Fly Essentially a Migrating Insect

After due consideration of these results and those of others it is impossible to escape the conviction that the house-fly under Montana conditions is essentially a migratory insect and not necessarily within localized areas. It is constantly moving from the field of one stimulus causing tropic reactions (that is, movements to or from) to that of another. Looking at Plate 21, which shows the dispersion of flies from the Sales Yards, does not the fact that flies were recaptured at this, that or the other place have an added significance beyond mere locality and distance. It means that each locality capable of attracting these flies became a subsidiary center for further distribution. The Sales Yards were an immense breeding ground. An extremely small proportion of their product was stained and recovered as shown, and that seventy-six of the released flies were captured at Station 216 means that this was only a small portion of the Sales Yards flies that actually reached this point. From it they spread to other localities and the station thus became a center of distribution subsidiary to that of the Sales Yards. This means that breeding and feeding areas are not necessarily areas which attract flies and retain them, but that

they may be considered as substations, so to speak, which aid and abet distribution and further increase the final radius of dispersion. Several reasons that may influence flies to leave such localities to which they have been attracted may be suggested. It is known that flies seek "shelter" at night. Where abundant the writer has seen them collect in the late afternoon by the thousands under the eaves and on the walls, especially on the south and west sides, of houses and buildings. It is apparent, then, that to reach such places a fly must leave the immediate vicinity of any feeding ground or breeding ground at which it was busy and there is no particular reason apparent why a fly should return to the same place when it resumes its activity in the morning. Indeed, whatever stimulus a feeding or breeding place may exert at midday under a strong sun would seem likely to be less intense in the cool of the morning. Similarly after a rain, stimuli may be less intense. Showers and changes of temperature may also cause flies to seek "shelter" and again it is a reasonable question to ask if there is any stronger reason why a fly should return to the place of its activities just before such an interruption than that it should go in some other direction? The direction of wind may have changed, and if stimuli may be wind-borne, which there is no good reason to doubt, may not the fly receive a stimulus from an entirely different direction? Other possible reasons for migration may be disturbance (flies in a business portion of a city are constantly being disturbed) and the removal of garbage, refuse, manure, etc., which serve as an attraction. Whether or not the fly can be said in general to leave a feeding or breeding place in response to other stimuli from similar places may be questioned. Indeed, an innate wandering instinct may sometimes be the cause but even then may not the direction of flight be controlled by external stimuli and since it is at feeding and breeding areas that flies are commonly found in abundance, is it not unreasonable to suppose that flies are sooner or later attracted by stimuli emanating from them, though such stimuli may perhaps not be correlated with the reason which initiated the movement? There is no apparent reason to assume that flies will necessarily stop at feeding or breeding areas nearest at hand.

Hindle has suggested the height of the point of liberation and the time of day are factors influencing the distance of dispersion. Bearing in mind that dispersion is primarily a problem of spread *from breeding areas* and that the life of a fly is a matter of several weeks, it is hard to assign a true significance to these points. Certainly it seems as if it would make very little difference in the ultimate distance a fly will ·aveled whether it emerged from its puparium in the morning

or evening. The height of the point of liberation may well affect the initial flight, but scarcely more.

This discussion concerning the factors of dispersion has necessarily been brief in order that it might not be unduly complicated. Other stimuli, such as phototropism and heliotropism might have been considered; undoubtedly they play their part in a minor way. Nor have all the ideas suggested by dealing with dispersion as a result of external stimuli been discussed in detail. Three further points should be mentioned. First, that stimuli acting at any given time may be considered as active or passive according as they do or do not cause a reaction on the part of the fly. Passive stimuli might well be termed latent. A stimulus active at one time may be passive at another and of several existing at the same time one may be active, the others passive. And again, active stimuli may be divided on the basis of their effect on movement or dispersion,—that is, some stimuli cause *movements* or *tropic responses* (stimuli from feeding and breeding areas, etc.), which result in dispersion, while others may cause inactivity (low temperatures, rain, etc.) which delays dispersion. The former are termed *inciting*, the latter *inhibiting*. When active some stimuli may be always inciting, while others may be always inhibiting, or the same stimulus may sometimes be inciting, sometimes inhibiting, depending on its quality and intensity as compared with other stimuli.

The second point concerns the standpoint from which the question of stimuli is viewed. The writer has considered them to be external and resultant movements as not in any way instinctive. Others, however, might choose to say that the stimuli which govern a fly's movements are of internal origin. As far as can be foreseen any arguments in support of this opinion can be equally well explained on the basis of external stimuli. For example, one might say that when the ova become mature the fly instinctively seeks a suitable breeding ground; but, on the other hand, it may well be suggested that the maturing ova cause some physiological change which makes the fly more receptive to the stimuli "thrown out" from such areas. Indeed, physiological changes must constantly be taking place and probably often determine the manner in which a fly reacts to the complex of stimuli which are constantly at work.

The third point concerns the fact that the results of this investigation have indicated that the distance to which flies may spread from any given breeding area under city conditions in Montana is considerably greater than that found in previous experiments in other localities. Considering that dispersion has to do with the spread of flies from a breeding ground, it at once becomes apparent that no

limit can safely be placed unless the time concerned is at least as long as average fly life and the number of flies in some measure approaches that number which we would expect to find emerging from a medium sized breeding area during the period of time concerned. In fact, to obtain the results desired, the number of flies used would have to be greatly in excess of this. But when we consider that in all previous experiments probably less than 50,000 flies were used and that the largest number used in any one experiment was 25,000, it is at once suggested that the difference in the numbers of flies used explains the difference in results (nearly 390,000 in this work). The explanation is as follows. It is a fair assumption that under normal conditions flies from any breeding area will spread in all directions, but will be most abundant at nearby feeding areas. From this "zone" of greatest abundance the ultimate result of fly migration will be outward though the number in the "zone" itself would be kept reasonably constant by continual additions from the breeding ground. It is apparent that, in a dispersion experiment using small numbers of flies, as they spread outward they become constantly fewer and fewer for any given unit of territory and consequently more and more scattered until a point is finally reached where the chances of recapture become reduced to infinity even though flies be actually present. But if the number of flies released is indefinitely increased, the possible number of flies per unit of territory at long distances is increased and consequently the possible limit of capture becomes constantly more and more distant until finally a "true" limit is reached, the actual location of which is dependent on the length of life of the average fly, while its actual determination must be based on experiment continued for this length of time and the use of a sufficiently large number of flies to permit their recapture at the dispersion limit. While this idea is merely offered as a possible explanation of why the results secured at Miles City differ so materially from earlier observations, it suggests as well that, by using a sufficiently large number of flies for a sufficiently long time and by making observation over a sufficiently large area, results could perhaps be obtained that would have more or less general application under balanced conditions.

Concerning Dispersion Over Open Country

No evidence of particular value was collected concerning dispersion across open country. On the 14th of August, 5,000 flies marked with gentian violet were liberated at a point midway between Fort Keogh and Miles City (Pl. 24, fig. 3). The prairie was barren for the intervening mile in each direction. A trap from the Sales Yards examined on August 21 contained thirteen of these flies and one from Keogh

examined on August 26 contained one. In order to reach the Sales Yards the flies had to cross a river several hundred feet wide. Fort Keogh was very clean and sanitary.

Evidence previously submitted showed that flies from breeding grounds within the city which was liberally spotted with attractive feeding and breeding areas, not only crossed it but 700 yards of open country beyond. This indicates that not only are breeding grounds outside a city of concern to its inhabitants, but that insanitary conditions within a city may also concern outside residents.

In respect to factors influencing dispersion across open country, the writer is again of the opinion that the two big factors are the stimuli from feeding and breeding areas, but with these differences; first, that such areas are relatively of small size; second that they are much farther apart; third, that the stimuli "thrown out" are weaker, and fourth, that other active stimuli may exert a relatively greater influence and act for relatively longer periods of time. Thus, in its existence in nature as undisturbed by man's occupation, we are justified in considering the house-fly as primarily a migratory insect.

Concerning General Distribution, Time of Distribution and Numbers of Flies

General Distribution.—From the data given on the maps it can be seen that flies from the several release points become quite generally distributed over the entire city and spread even beyond its limits. An examination of the data in Table II gives ample evidence on this point. A trap placed at Station 214 for four days (July 24 to 28) captured flies from the Sales Yards, City Dump and Laboratory; one placed at Station 208 for four days (July 31 to August 4) captured flies from the same three release points; one placed at Station 105 for three days (August 3 to 6) captured flies from the Sales Yards, Laboratory and Washington School; one placed at Station 119 for four days (August 6 to 10) also captured flies from these three release points; one placed at Station 224 for four days (August 7 to 11) captured flies from all four release points; one placed at Station 33 for two days (August 12 to 14) captured flies from the Sales Yards, City Dump and Washington School; one placed at Station 127 for three days (August 14 to 17) captured flies from the Sales Yards, Laboratory and City Dump and three placed at the State Industrial School (Station 62), 700 yards beyond the eastern limits of the city, captured flies from all points during a period of eleven days (August 9 to 20). These illustrations are few in comparison to the data available, but have been purposely selected to cover all sections of the city, thus indicating the general distribution from each point of release.

The fact that the map shows the stations at which recaptures were made to be mainly grouped in certain sections is due to the fact that it was found necessary to discontinue the work somewhat earlier than planned. Consequently the portion of the city remaining unworked was covered very rapidly, but flies were captured at practically all stations. A consideration of the *areas* covered by these last settings gives further evidence of how generally the liberated flies were scattered. For example, traps were placed at stations 31, 32, 33, 34, 35, 36, 37 and 38 from August 10 to 12 and flies were recovered from all release points except the Laboratory. Placed again from August 12 to 14 flies were recovered from all points. Other areas show similar results.

It has previously been stated that the built-up portion of Miles City was about two square miles in area. For the present purpose we may consider that the Sales Yards was at one corner of a square containing the city which is essentially correct. A breeding ground under usual conditions is a center from which flies would normally spread equally in all directions given similar conditions. This would indicate that flies from a breeding ground may spread over eight square miles of territory, or by taking the longest radius encountered within city limits (2,333 yards) we would get an area of nearly five square miles, and again by taking the longest radius actually encountered (3,500 yards) we get a territory of more than twelve square miles.

These details are important as they indicate several facts of practical significance—(1) that, given sufficient time, a given lot of flies from a breeding ground will become quite evenly scattered over large areas, (2) that even in a city of considerable size, every person allowing flies to breed on his premises is maintaining a nuisance which directly concerns every other individual residing in the city, (3) they emphasize the importance of general coöperation in order to secure successful results in control work (the cleaning up of a few places here and there has little value), (4) they indicate the far-reaching effectiveness of intensively applied control measures as a means of securing general sanitary conditions.

Concerning Time of Dispersion and Numbers of Flies.—Due to the repeated lots of flies released and the several day intervals at which traps were collected, the data concerning time required to spread given distances has no great value. It does indicate some facts, however. By reviewing the data for dispersion from the Sales Yards, it is evident that flies from this release point spread over the entire city, within a period of two to three weeks. From this point 248,140 flies were released. The Laboratory release point, on the other hand, represents only 35,270 house-flies and is comparable

to a very small breeding ground. In this case the period for the flies to become generally distributed is slightly longer according to the data, but probably not as an actual fact. Distances of over a mile were noted within a five-day period.

The summer's results have suggested that, if it were possible to liberate varying quantities of flies at stated intervals during a long period of time and to have a large number of permanent recapture stations from which flies were collected at daily intervals, results could be secured of some importance from the standpoint of disease transmission. The stations should be equally spaced and divided into successive zones of 100 yards width. The data secured would concern the following points: the average length of life of a fly, the number of flies liberated, the number recaptured at each station, the number recaptured in zones (each 100 yards more distant from the point of liberation), the time required to reach given stations, and the time to reach given zones. This data would permit averages to be figured that would indicate the probable distribution of any given lot of flies at any given time after liberation. Knowing then the length of life of any disease organism on the outside of a fly or in its intestine, it would be possible to establish a theoretical limit to which flies would be likely to carry virulent organisms from any point of contamination. Also, if at any given station the number of flies captured was in excess of the theoretical number expected, it would imply that this excess was explainable by unusual attractiveness or some other cause and hence would indicate the character of places at which the probabilities of contagion would be greatest.

Conclusion

The writer wishes to emphasize the fact that he by no means considers the preceding discussion to be any more than an addition to previous knowledge of fly dispersion. The suggestion that the stimuli emanating from breeding and feeding areas are the factors mainly responsible for seasonal dispersion under city conditions finds considerable support in the data presented and is not at variance with data previously published. It harmonizes better than any other suggestion with conditions as studied in the cities and towns of Montana and finds some support in the known habits and life history of the house-fly.

In spite of the fact that the number of flies used was greatly in excess of that of all previous experiments combined, it is felt that far larger numbers could be used to great advantage. Much remains to be learned concerning fly dispersion under various conditions and whatever evidence can be found to support different view points, the

final word, nevertheless, cannot be spoken until incontrovertible evidence has been gleaned from further experimental work.

Summary of Data and Results

General Summary

1. In a city, the built-up portion of which was about one and one-half miles square, 387,877 marked flies were liberated from four release points. The release points were so located as to give an idea of the possible spread of flies from breeding areas variously situated in relation to the city as a whole and each representing different conditions.

2. A total of 1,056 flies were recaptured at seventy-eight stations which varied from 50 to 3,500 yards from the point of release. This was the greatest distance at which recaptures were attempted.

3. The results indicated that under conditions which are favorable flies may spread from any given breeding ground to all parts of a city, even one of considerable size. Also that they may not only cross a city offering abundant feeding and breeding areas, but may even leave it and cross open country to points considerable distances beyond its limits.

4. The full possibilities of dispersion were not determined due to the relatively small size of the city, but the fact that flies spread from release points on one border to points on the opposite side indicates a possible radius of 2,333 yards (one and one-third miles) and that flies even traversed the entire city and crossed open country to points beyond justifies the belief in a still greater radius. The actual territory over which flies were recovered in the city was about two square miles, but possible dispersion over a territory of from five to more than twelve square miles was indicated.

5. While the results of this investigation are of general application to Montana cities and towns, it is problematical to attempt to apply them to more thickly populated areas where sanitary measures are more easily and more generally applied. Control measures mean fewer flies and fewer feeding and breeding areas, but does this mean a larger or a smaller radius of dispersion for what flies there may be?

Summary of Deductive Results

1. House-fly dispersion (the spread of house-flies from their breeding grounds and the factors controlling it) may be considered as a problem concerning short periods of time or as one of seasonal significance.

2. The factors which control dispersion are mainly, if not entirely, external stimuli. As regards their effect on the radius of distribution, these stimuli may be termed, *inciting* (*e. g.*, odors from feeding and

breeding grounds) or *inhibiting* (*e. g.*, low temperature, rain). Inciting stimuli give rise to tropic reactions, movements to and from, and consequently have a direct effect on distribution. Inhibiting stimuli indirectly affect distribution, because of resulting periods of inactivity on the part of the fly.

3. These stimuli, both inciting and inhibiting, form a complex set of external forces, each of which varies in intensity and duration.

4. The adult life of the house-fly is essentially devoted to two purposes, feeding and reproduction. Hence, it is evident that when dispersion is considered as a problem of long periods or of seasonal duration, that the stimuli from feeding and breeding areas are those of the inciting stimuli which act most continuously and for the greatest portion of a fly life and are the most important ones to control. Temperature is a constantly present stimulus, but may be inciting or inhibiting.

5. When dispersion is considered for short intervals other stimuli than those from feeding and breeding areas may assume greater importance. These stimuli may be inciting or inhibiting and under normal conditions have but minor significance as seasonal factors. Cities or localities undoubtedly occur, however, in which unusual physical or meteorological conditions are present with but slightly varying intensity during a complete season and consequently what would ordinarily be a stimulus of minor importance may become one of major seasonal importance (*e. g.*, strong wind blowing constantly from some direction, long continued rain, etc.).

6. By conducting dispersion experiments with a sufficiently large number of flies for a sufficiently long time and by covering a sufficiently large territory it seems likely that a limit for fly dispersion, under city conditions, could be determined which would be of more or less general application. The length of time would have to be at least equal to that of the average length of house-fly life.

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Explanation of Plates 24—26

Fig. 1. Showing approximate location of Sales Yards release point (x). Miles City beyond trees in background.
Fig. 2. Looking toward Miles City from Sales Yards release point.
Fig. 3. Looking toward Miles City from vicinity of release point on prairie one mile west of city.
Fig. 4. City Park which is between the river bed of Figure 2 and Miles City.
Fig. 5. Character of the country between Laboratory and State Industrial School (x).
Fig. 6. Release point—City Dump.
Fig. 7. Part of the Miles City horse sales yards.
Fig. 8. Privy (x) and manure pile (o) near Station 216.
Fig. 9. Privy with open vault near door to Station 216.
Fig. 10. Laboratory (x) and city in background.
Fig. 11. Trap used at Sales Yards (Station 168).

SOME OBSERVATIONS ON THE BREEDING HABITS OF THE COMMON HOUSE-FLY (MUSCA DOMESTICA LINNÆUS)

By Arthur T. Evans

During the past summer a number of experiments were conducted by the writer relative to the breeding habits of the common house-fly, *Musca domestica*. It is a somewhat popular belief that the house-fly is able to and does breed abundantly in garbage, manure and any other rubbish which may be accessible. As definite records on the breeding places of this fly were somewhat limited it was decided that a thorough search should be made of numbers of garbage cans, manure piles and any rubbish heaps that were found available to see if the larvæ could actually be found in these various conditions. The garbage cans examined contained many kinds of garbage in various stages of decay. With a single exception no larvæ of the house-fly were found in the cans examined. The larvæ as well as the adults of the small fruit-fly, *Drosophila* sp., appeared abundant in almost every can examined. Upon opening a garbage pail the adults of this insect usually fly out in numbers. It may be due to this fact that it is so generally believed

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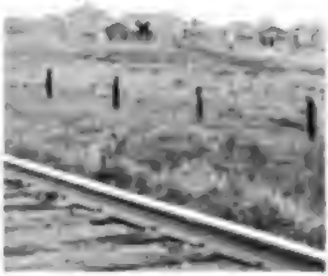

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that the house-fly breeds there, the adults of *Drosophila* being taken, by those who do not know, to be the young of the house-fly. Manure piles in the vicinity of the garbage cans studied were examined when possible and in every case the house-fly in all of its stages was found to be abundant. In the examination of manure piles the pupæ as well as the larvæ about to pupate were most abundant about the outer edge of the piles, in the loose straw or even in the earth. In one case where the manure was thrown into a low wagon the larvæ migrated to the bottom of the wagon box, where they fell through the cracks and buried themselves in the top layer of earth preparatory to pupation. Migration of the larvæ of the house-fly has been studied by various writers (1) and is recorded here merely as additional facts observed.

Another point noticed was that the larvæ avoided the deeper parts of the piles which were wetter from the seepage of moisture from the upper layers. This will be more fully discussed under the reaction of larvæ to moisture.

Although no larvæ were found in the rubbish examined not enough was studied to warrant forming an opinion. By rubbish is meant any trash other than that which might be classified as garbage or manure. The manure studied in all cases where not otherwise mentioned was the refuse from barns where horses were quartered.

The lack of the larvæ of the house-fly in garbage together with its abundance in stable manure seemed to indicate that there was some difference between the two substances which in the case of the manure furnished an optimum condition for fly breeding and was prohibitory in the case of the garbage. A chemical difference seemed the logical one to assume. Since the substance which was prohibitory in the garbage might prove to be a good larvicide an effort was made to determine it if possible. Quantities of garbage and stable manure were brought into the laboratory for study. When tested the manure was found to be alkaline while the garbage was acid. As ammonia is known to be present in manure several tests were made to determine the relative amount present. The tests showed the amount to vary with the length of time that the manure had been standing. Manure which had been standing no longer than thirty minutes was found to contain .647 of a per cent. That which had been standing for a longer period contained less; even as little as .314 of a per cent.[1] In cases

[1] These tests were made in the chemical laboratory of the University of Colorado. The writer is indebted to Professor Harry Curtis for the privileges of the laboratory as well as suggestions as to methods. I wish also to acknowledge the following assistance: Professor T. D. A. Cockerell for several important references as well as his kindly interest in the work; Professor A. H. Peebles for the loan of a book; and Professor Francis Ramaley for reading the paper for me.

where the manure had been standing for any considerable length of time it is quite certain that some of the ammonia passes off into the air. With all of the manure examined there was mixed more or less urine. No manure which had been standing for more than a day was tested as it was known that flies do not lay their eggs in such if fresh manure is present. The juice was extracted from a quantity of garbage to test relatively its acidity. The complexity of garbage indicates that a number of acids are usually present, these probably varying with the substances which are placed in the garbage can. No effort was made to determine the acids which were present in any can as this undoubtedly would vary with each can. It suffices to say that there were enough acids present to neutralize an equal amount of ammonia of a strength of .653 of a per cent. This per cent was found to vary with the staleness or freshness of the material in the can. In no case was acid found to be absent from garbage if it had stood for some time and was rotten.

After having found the relative amounts of alkali in manure and acid in garbage a number of experiments were conducted to determine if possible the maximum amounts of either of these substances which the house-fly might be able to breed in. A quantity of manure was brought into the laboratory and leached out with distilled water. When thoroughly washed the remaining solid material was pressed until all of the water possible was removed. A portion of this material was placed in each of six bottles. Enough ammonia was added to moisten well but not saturate the material. The ammonia varied in strength in the case of each bottle, the actual strengths being as follows: bottle 1, .001 per cent; bottle 2, .05 per cent; bottle 3, .1 per cent; bottle 4, .7 per cent; bottle 5, 1.4 per cent; and bottle 6, 2.1 per cent. A similar series of bottles was arranged with the difference that hydrochloric acid was added to the manure instead of ammonia. The strengths used in the various bottles were: bottle 1, .001 per cent; bottle 2, .025 per cent; bottle 3, .05 per cent; bottle 4, .1 per cent; and bottle 5, .561 per cent. In each bottle of both series was placed a mass of eggs which had been laid by flies kept in confinement with meat. Each bottle was then corked to prevent the escape of its contents.

After standing for several days in the laboratory the following observations were made: bottles 1, 2, 3 and 4 of the alkaline series contained a large number of larvæ. In bottle 5 but two larvæ had hatched. In bottle 6 but one had appeared. In both these last named bottles numbers of eggs had not hatched. No effort was made to determine whether all of the eggs had hatched in the other bottles as the number of larvæ present indicated that a large percentage had. The larvæ in this series pupated and metamorphosed into adults in a regular

manner except in bottles 5 and 6 where they wandered about a great deal, appearing restless. From these observations it appears that the highest amount of ammonia that the house-fly is able to breed in successfully lies between .7 per cent and 1.4 per cent.

An examination of the acid series showed that the eggs had hatched in only bottles 1 and 2. Bottle 1 contained three larvæ while bottle 2 contained but one. All of these larvæ left the manure and crawled about the sides of the bottles. None of the eggs had hatched in the other bottles.

Another series of experiments similar to those conducted on the eggs was carried out using larvæ instead. A number of the larvæ were placed in each bottle of the acid and alkaline series and were found immediately to bury themselves in the moistened manure. The next morning a number of the larvæ in bottles 5 and 6 of the alkaline series were found to be dead. The rest had left the manure to crawl about the sides of the bottles. Later a single larva in bottle 6 pupated. The larvæ in the other four bottles remained buried in the manure and a few days later had pupated. These metamorphosed into adults in a regular manner. The larvæ remained buried in the acid series for a short time, when they left the manure to crawl restlessly about the bottles in which they were confined. Those in the higher percentages of acid died on the second day; those in the lower percentages lived for some time but eventually died. None were found to have pupated in the acid series.

Only three experiments were conducted with the pupæ. A number of pupæ had been found to metamorphose regularly from alkali during the course of the other experiments so it was not thought necessary to test their resistance for more than the higher strengths. This was also done for acid as well as distilled water. Large numbers of pupæ when placed in earth which had been moistened with distilled water, .75 per cent acid or 2.1 per cent ammonia, were found to metamorphose seemingly without inhibition. This probably indicates that the pupæ are insensible to substances which may be larvicides. The tough coat of the pupa undoubtedly serves as a good protection. Earth was used in these experiments instead of manure as the larvæ are known to pupate in earth when possible.

An attempt was made to get flies to breed in garbage by confining them with it but in no case were they found ever to lay their eggs when so confined. Manure which had been leached out was moistened with the juice of garbage and a number of flies placed with it but all efforts to get them to breed in it failed. When larvæ were placed with such manure they left it soon and crawled about the containing

vessel. Although the garbage juice was not tested as to strength it was known to be acid.

In all of the work done thus far the eggs as well as the larvæ seem unable to develop in acid media, but up to a certain percentage they were found to develop in alkaline media. Tests indicated that acid has strong larvicidal properties. To determine this with more certainty a number of experiments were undertaken. A quantity of fresh horse manure which flies were known not to have laid their eggs upon was secured. Three portions of this were taken, each containing about a quart of solid manure. The first portion was confined under a bell jar with two flies. This manure was untreated. The second portion was confined under a bell jar with twelve flies. This manure was sprayed with a .75 per cent solution of hydrochloric acid. The third portion was divided into four smaller parts. On each of these parts was put a mass of eggs. The whole was then sprayed with a .75 per cent solution of hydrochloric acid. The parts were then confined in bottles. All of the cultures were examined from time to time for several days. The results observed were as follows: portion 1, which had not been treated, was found to contain great numbers of larvæ. The second portion, which had been sprayed and confined with twelve flies, contained but four larvæ. The third portion, which after being sprayed and impregnated with eggs had been divided among four bottles, was found to have developed larvæ in only one bottle and then only in small numbers. The larvæ were tiny and had left the manure to crawl about the bottle. Some, however, were unable to get out of the manure and had died. Manure which was well infested with both larvæ and eggs was sprayed with .75 per cent hydrochloric acid and placed under a bell jar. At the end of three days many of the larvæ were dead and many of the masses of eggs had not hatched, due to their being killed by the acid. Larvæ which were not dead had left the manure. Whether any great number of the eggs had hatched is doubtful, although no effort was made to determine this. It is quite probable that eggs just ready to hatch might finish the process even if treated with acid in this way, although the escape of larvæ from the manure would be difficult. Many would probably die before they could get out of it. Any remaining in the manure would certainly perish.

Old rags have been more or less discussed, especially by popular writers, as a favorable situation in which flies would breed. A number of rags were moistened and placed with a few flies beneath a bell jar. The flies were found to deposit their eggs upon them and in a few days the eggs hatched. As the rags were relatively clean the larvæ were unable to get food, so soon left them. Dr. Hewitt has found (2) flies

feeding in old rags which had been fouled with excreta. The excreta in this case probably furnished enough food for the development of the larvæ. It seems quite probable that flies might lay directly in rags under such conditions but the writer does not believe that flies will lay eggs in rags which do not contain a food supply. Without a food supply the larvæ would have to migrate or perish. It is very unlikely that flies would lay eggs where food would not be plentiful for the larvæ, especially with food so abundant as it is during the summer. Migration from a breeding place without food to a food supply would undoubtedly result in the death of many larvae unless the food supply was very close; in which case the eggs would very likely be deposited in the food supply when laid.

During the course of the various experiments it was noticed that the larvæ were especially sensitive to an excess of moisture. If too much of the solutions was added to the media the larvæ invariably would leave the media and go into a drier portion of the vessel. This was also noticed in the examination of the wetter portions of manure piles and especially the deeper, wet portions of bins. Although most of the bins examined were found to be faulty in construction so that many flies could gain access, yet the number of larvæ present were few. They were found to be prevented from breeding in the upper layers due to a layer of mold which developed over the top of the manure after it had stood for a short time in the bin. Its excellent development here is probably due to the constant temperature furnished by the fermenting of the manure below. Cow dung as dropped in the pasture was examined, as it was known to be saturated. No larvæ were found in the manure but they were sometimes present in the layer of earth just beneath the manure. The eggs were found to be deposited at the base of the pile near the ground into which the larvæ were able to enter soon after hatching. In this position beneath the pile the larvæ are kept supplied with food which seeps down from the pile above. The very few larvæ in cow manure indicate that it is not one of the favorable places for fly breeding. This probably is due largely to the amount of moisture that it contains as well as the compact form in which it is found.

Very little of the work which has been done on the fly deals with its relationship to garbage. During the summer months this is one of the problems of every city. Hundreds of flies swarm about exposed garbage. Their mission seems to be one of feeding rather than breeding. If one examines the manure heaps during the summer even more flies are found to be present. This is their real breeding place. Only one garbage pail was found during this work which contained larvæ. This contained a quantity of sardines and was teeming with maggots.

When tested it was found to be neutral. The presence of acid in garbage cans where the larvæ do not occur seems to indicate that it is the prohibitory factor. Paine (3) found the larvæ of the house-fly abundant in garbage pails but no observations seem to have been made as to the reaction of the contents of the pails which contained them. Observations carried out under the supervision of Forbes (4) in 1908 and 1909 have shown that flies may breed in a great variety of substances. In studying over the list from which larvæ were recorded in these observations, it is interesting to note the small number of larvæ taken from material which often goes to make up garbage. Materials which contained but a single larvæ are: rotten cabbage stump, banana peelings, cooked peas, and seepage from garbage pile. Other substances which might form a part of the contents of any garbage can with the number of larvæ each contained are: rotten bread and cake, 8; rotten watermelon and muskmelon, 14; rotten potato peelings, 12; old garbage, city dump, 15; rotten carrots and cucumbers, 23. Kitchen slop and offal was recorded as producing 193 larvæ. According to the experiments recorded in Forbes' paper this latter might be prohibitory to house-flies in two ways. It might be wet as the name would indicate that it was, or it might be acid. If it was wet to saturation and the larvæ were found in it, then the results are the exact opposite to those which I have obtained. It is quite possible that flies are able to breed in fresh garbage before it has had time to rot or become contaminated with any that has already rotted. Again, large pieces of any substance may furnish a breeding place for a number of flies. A mixture of the contents of the can when fresh garbage is added would undoubtedly prevent the laying of eggs upon fresh garbage by flies. In all of the cases where garbage was used in these experiments no large pieces of any one substance were taken. The garbage taken was in a rotten condition and was so thoroughly mixed that the substances which made it up could not be identified.

Manure or garbage sprayed with an acid of a strength of .75 of one percent would undoubtedly be unfit as a breeding place for flies. The dilution here suggested is so great that the cost would be very little if "commercial" hydrochloric acid were used. This acid which was used successfully in these experiments, when used in such dilute proportions would very likely not destroy the value of manure as a fertilizer. Undoubtedly any other acid would prove as good a larvicide. Although the spraying of open piles was not attempted owing to the lateness in the summer, it is believed that an acid spray could be used with good chances of success.

Summary

1. With one exception house-flies have not been found breeding in garbage. In this case the garbage was neutral. Their presence about garbage cans is for feeding purposes.

2. The eggs and larvæ were able to develop in manure wet with ammonia up to .7 per cent in a seemingly regular manner. Above this per cent their development is more or less inhibited.

3. The development of eggs and larvae was found to be inhibited in all strengths of hydrochloric acid.

4. The pupæ metamorphose regularly from both acid and alkali which is prohibitory to the eggs and larvæ.

5. Spraying of manure containing eggs and larvæ prevents to a great extent their further development. When manure is sprayed it prevents largely the deposition of eggs.

6 House-fly larvæ were not found living in the body of cow droppings. They were found in small numbers in the layer of earth just below the pile.

7. The larvæ were found to be sensitive to moisture in large quantities. When a medium was too wet they were found to leave it in a manner quite similar to their reaction in the case of acid.

8. Manure stored in bins was found not to be a good place for the breeding of flies due to the growth of mold which is usually found on top and also to the wet condition of the manure deeper down.

9. Hydrochloric acid was found to be an effective larvicide.

In an interesting paper (5) which has appeared since the completion of this work, M. E. Roubaud working in the military camps of the French army found that he was able to destroy the larvæ of the domestic fly by merely turning the inner parts of the pile over the fresh manure which contains larvæ. He finds that the heat generated by the manure as well as the gases which are formed during fermentation are very fatal to the larvæ when they are exposed to them. At 50 C. the larvæ are killed in three minutes; at 51 C. in one minute; at 59 C. in five to seven seconds; and at 60 C. in from four to five seconds. He has found that the middle of a manure pile may develop a heat of from 70 to 90 C. He also finds that flies do not breed to any extent in garbage. It seems justifiable to think that this developed heat may be the cause of so few larvæ in the center of the manure piles examined during the course of the work, reported by the present writer; it may also account for their not breeding well in manure bins. Roubaud does not state why flies do not breed well in garbage.

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PROFESSOR GOSSARD'S THEORY ON FIREBLIGHT TRANSMISSION

By E. F. Phillips, *Bureau of Entomology, U. S. Dept. of Agriculture*

In the February number of the Journal, there appears a paper[1] which Professor Gossard read at the Columbus meeting. Without presuming to know anything about fireblight or of the distribution of the causal organisms, it seems justifiable to examine the validity of his conclusions. If the hive does serve as a distributing center of the organisms, the fact will be accepted when adequate proof is presented, but in the meantime an attempt to point out the fallacies in the theory will only help to arrive at the truth. Although the author says "it must be remembered that this surmise, as yet, rests upon inference only," attention should be called to the total lack of experimental data to support the surmise.

The proof presented by Professor Gossard is as follows:

1. *Bacillus amylovorus* was not found in old honey from three hives in the spring. It is not shown that blight is carried over in that way.

2. *Bacillus amylovorus* was not found in fresh apple honey in five hives, from one of which the bees certainly worked on blighted blossoms.

3. *Bacillus amylovorus* lived in artificially inoculated sterilized honey up to 43 hours and 25 minutes and, when cultures from these were injected into apple twigs, blight usually resulted in 100 per cent

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[1] Gossard, H. A., 1916. Is the hive a center for distributing fireblight? Is Aphid honeydew a medium for spreading blight? Jr. Econ. Ent. IX, 1, pp. 59–62.

of cases. The method of sterilizing and its action on the honey are not specified, although these may be of vital importance.

4. *Bacillus amylovorus* lived in artificially inoculated unsterilized honey in one case 47 hours and when this honey was injected into twigs, blight resulted in 52 per cent of cases.

5. The longer the time the organisms remained in unsterilized honey, the less the percentage of resulting infection. It is indicated that these organisms ultimately died in honey but the data are not presented on this point.

6. There is no evidence of growth of the organisms in honey. However, the author speculates that they may grow.

According to the evidence presented, there is no proof that the bacteria even enter the hive. No person will be inclined to deny the possibility that they do, but so long as all proof is lacking for the theory that the hive is a distribution center, we are justified in refusing to accept it. The fact that the organisms lived in honey for a time and then died is interesting, but the value of these facts as support for the theory is at best slight.

Since honeybees are often more abundant than other insects in the orchard during the blooming period and since a bee often visits dozens of blossoms on one trip and makes dozens of trips a day, it is only necessary to show that honeybees actually carry blight from flower to flower to account for a wholesale distribution. In the face of the evidence presented by Merrill (Jr. Ec. Ent. VIII, p. 402) that there is a relation between the number of green aphids and the amount of blight, it is evident that there is still room for investigations as to the office of the bee in this distribution. Waite showed that the honeybee can carry the blight organism from artificially inoculated blossoms on their mouthparts. What is now needed is additional evidence as to the relative importance of flying insects and piercing aphids in the transmission of the disease.

Gossard incorrectly assumes a rather general mixing up of the honey in the hive during the ripening process. The young bees of the hive do this work and the possibility that these bees will become field bees before the blooming period closes is most remote. While bees sometimes touch each other with their mouthparts, this is not sufficiently common to account for wholesale distribution of the organisms. Furthermore, nectar from fruit blossoms is usually consumed immediately and if not needed at once is ripened and stored in a few hours. The behavior of bees inside the hive seems to offer no support for the inferences drawn for this theory. It is pertinent to suggest the desirability of trying to isolate *Bacillus amylovorus* from the mouthparts of bees leaving the hive.

DETECTION OF ARSENIC IN BEES[1]

By E. B. Holland

The high periodical mortality in numerous apiaries of the state during the past few years has led to the examination in the Station laboratory of many samples of bees and of comb submitted by the Station apiarist. As a rule, little information was obtainable except that a large percentage of a colony or colonies had died within two or three days. Disease was not considered the cause of death as no disease of the adult bee has as yet been recognized. On the other hand, the old theory of poisoning, so often advanced as a solution of like problems, appeared more plausible than usual in view of the fact that spraying with arsenate of lead or with Paris green has become the general practice of farmers, horticulturists and tree wardens for protection against leaf-eating insects. Furthermore, bees obtain pollen and nectar from a large number of "honey" plants over an area of approximately a dozen square miles (two mile radius)[2] and are very active during the spraying season. Bees, therefore, must be particularly liable to injury if arsenical or other "stomach poison" insecticides are used in the vicinity. The above assumption was substantiated in a large measure by chemical examination. A small amount of arsenic was found in 12 samples out of 23 submitted, as shown by the following table. The detection of arsenic in stored pollen was of special interest.

Results of Analyses

	Arsenic Present	Possible Trace	No Arsenic	Total
Bees	10	2	6	18
Comb	2	1	2	5
Percentage	52	13	35	100

At least 10 grams of material are deemed necessary for satisfactory work. Considerable labor is involved, however, in collecting that number of bees free from dirt and litter. As the amounts employed varied from 40 grams to less than 2, the tests are not strictly comparable. Moreover, the percentage of reacting samples was substantially reduced by including several lots secured in the course of the work that were not even suspected of poisoning.

[1] Published with the approval of the Director of the Massachusetts Agricultural Experiment Station.

[2] According to J. L. Byard, superintendent of the College apiary.

Methods for Destroying the Organic Matter

At the outset the organic matter in the samples was destroyed with sulfuric and nitric acids. These agents were first suggested to the writer by the late Dr. Goessmann in place of hydrochloric acid and potassium chlorate formerly employed for the purpose in the station laboratory. The process requires time and patience to insure *complete* destruction of the organic matter but is satisfactory as a whole and preferable to the old method.

As the number of samples increased and the demand for an early report became more urgent, an effort was made to improvise a process to meet those conditions with the least possible interference with regular work. An attempt at treating with potassium chlorate and igniting (an old method for wall paper) proved impracticable, and hydrogen peroxide proved inefficient as an oxidizer. Sodium peroxide, potassium bichromate and potassium permanganate were also considered. The last appeared the most promising and could be used readily as a saturated solution. The combined winter losses of two apiaries furnished a liberal supply of bees for experimental work.

Method Employed

Representative portions of the bees as received and with an added amount of arsenous oxide or of arsenic oxide were macerated in a platinum dish with a saturated permanganate solution (20 c.c. to each gram of material), evaporated to dryness, heated at a temperature not exceeding faint redness, pulverized and reheated until the residue would no longer "glow." The "crude" ash was transferred to a Marsh apparatus with sulfuric acid (1–3) and gave, in cases of added arsenic, a positive inside mirror. Several samples of suspected hay also reacted with the above test; evidently due to heedlesss spraying of the grass. Possibly permanganate has been used in this connection by other workers as it is now employed for many oxidizing purposes in most laboratories. Nevertheless, our method of procedure together with results secured are offered in the hope that they may prove of service.

Toxic Dose of Arsenic for Bees

So far as noted there have been no reliable data published as to the toxic dose of arsenic for bees. The arsenical compounds generally employed as insecticides are salts of lead, copper and lime. Although lead and copper have toxic properties, arsenic should be considered the active principle of the insecticide. Practical experience indicates that a given weight of arsenic (As) in the form of arsenites (As_2O_3) is more poisonous than in arsenates (As_2O_5). This appears to hold true

in relation to plant as well as animal life. While no positive statements are possible owing to lack of sufficient data, 65 milligrams of arsenous oxide (white arsenic) to 1,000 grams of live weight may approximate the toxic dose[1] for the horse, ox, sheep and fowl, and 9 milligrams for the dog and pig. On the former basis of susceptibility, 65 milligrams of arsenous oxide (equivalent chemically to 76 milligrams of As_2O_5) would kill 1,000 grams (net weight) of bees or 12,658 individual workers[2] weighing 79 milligrams each, or on the latter basis of susceptibility, 9 milligrams of arsenous oxide would accomplish the same results. The toxic dose for bees is unquestionably small, whatever the figure, as a considerable portion of the arsenic detected in the samples was evidently in the bee load and not assimilated as shown by the following treatment. A lot of bees containing arsenic, after being shaken with 1 per cent nitric acid for 1 minute and rinsed twice with water, gave only a "possible trace" of arsenic. Another portion treated similarly with 3 per cent nitric acid would no longer react. The use of 3 per cent acid proved inadvisable, however, as it was found too active for even so short a period. The above test would indicate that bees are susceptible to even less arsenic than is detected in the original samples.

The work will be continued during the coming season with a view of determining the amount of arsenic present.

INJURY TO PEANUTS BY THE TWELVE-SPOTTED CUCUMBER BEETLE[3]

(*Diabrotica 12-punctata* Ol.)

By David E. Fink, *Entomological Assistant, Truck Crop and Stored Product Insect Investigations*

Introduction

The adult of the twelve-spotted cucumber beetle (*Diabrotia 12-punctata* Ol.) is well-known as nearly omnivorous in its feeding habits, and in Tidewater Virginia, occurs on practically all truck crops. Because of this omnivorous habit, their injury to any one particular truck crop is sometimes nearly negligible, except at intervals when few crops are in the fields. The larvæ of this species are also well

[1] Calculated from data cited by Nunn, Veterinary Toxicology.

[2] Workers containing little or no feces average about 79 milligrams in weight; on leaving the hive in the morning during the active season the feces may constitute an additional 25 milligrams; a load of honey varies from 22 milligrams to several times that weight. From various references furnished by Dr. B. N. Gates of this Station.

[3] Published by permission of the Secretary of Agriculture.

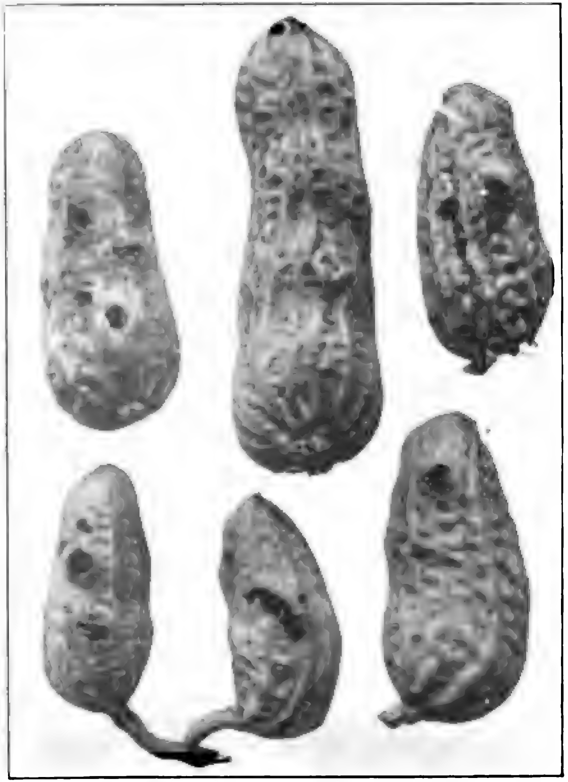

Fig. 1

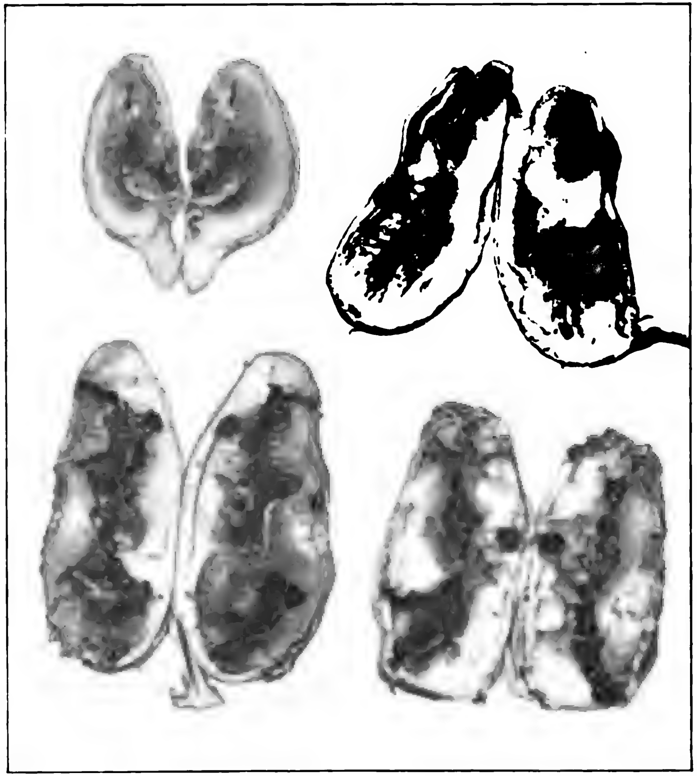

Fig. 2

known, at times, to seriously injure truck and other crops by feeding on the roots. Particularly is this the case with a growing crop like corn. that occupies the land for a comparatively long time.

Since 1908,[1] and especially for the past three years, peanuts, which were hitherto considered to be free from insect attack, were observed to be injured by larvæ boring into the pods just as they were beginning to form, and afterwards almost entirely destroying the contents by feeding on the interior tissues. During the years 1913 and 1914, owing to the few larvæ then actually found in the pods, no attempt was made to rear the adult. In the summer of 1915, however, the injury to peanut pods was observed to be extensive, and larvæ comparatively abundant with the result that the reared adults were determined as *Diabrotica 12-punctata* Ol.

Nature and Extent of Injury

At the Virginia Truck Crop Experiment Station, Norfolk, Va., two plats—each about a third of an acre in size—are used experimentally for the growing of peanuts. Plat 1 is used exclusively for peanuts. In plat 2, peanuts are used in rotation with corn and potatoes, once in three years. At intervals during the months of August and September, 1915, peanut plants were dug from both plats, and the pods were carefully examined to determine the extent and nature of the injury. Observations made at the time indicated that the younger and softer pods were usually the most seriously injured. The number of holes found in a pod varied from one to three or more, but rarely was more than one larva found in a single pod. The larvæ attack the pods at various places appearing, however, to favor the free end. After gaining entrance to the interior, the larva feeds on the contents. In more matured pods their work becomes more defined by tunnelling through the kernels. Injured pods when cut longitudinally clearly show this condition (see Pl. 27, Fig. 2).

In many instances young larvæ gain entrance to pods in which the rate of growth is proportionally greater than the growth of the larvæ. As the food contents soon become too hard, the larvæ invariably leave such pods to enter others. Matured peanut pods, as a rule, are seldom observed injured, although the exterior of such pods

[1] Observations were conducted on this larva on peanuts that year by Messrs. C. H. Popenoe and F. H. Chittenden, and the following year by Mr. E. G. Smyth.

Expvanation of Plate 27

Fig. 1. Peanut pod showing entrance and exit holes made by the larvae of the twelve-spotted cucumber beetle (*Diabrotica 12-punctata*).

Fig. 2. Peanut pods cut longitudinally to show the work of the larvae of the twelve-spotted cucumber beetle (*Diabrotica 12-punctata*.)

evidences many attempts to gain entrance. Growing plants in which the pods mature rapidly are less susceptible to larval injury, while plants that make vigorous vine growth but through some unknown cause fail to mature the pods rapidly, usually prove on examination to be vigorously attacked by the larvæ. In plants which have died as a result of disease, the pods are either free from larval injury, or indicate that they are less subject to such attacks. This tends to confirm the statement that rapidly maturing pods are seldom injured by the larvæ. In some instances nearly the entire crop of pods borne by a plant may be injured, while in others the proportion of injured to uninjured pods is about equal. On plat 1, where peanuts are grown each year, the pods indicate a greater percentage of larval infestation than on plat 2, where peanuts are grown in rotation with other crops.

The peanuts on both plats were harvested on October 18 and 19. In order to ascertain the percentage of infestation, a certain definite weight of peanut pods from both plats 1 and 2 was examined, and all pods that indicated larval injury were separated from the uninjured ones and their respective weights obtained.

The total weight of peanut pods examined from plat 1, was 15¼ pounds, this amount gave 8 pounds not injured to 7¼ pounds injured pods. The percentage, therefore, was 53 uninjured and 47 injured pods.

The total weight of peanut pods examined from plat 2, was 10½ pounds, this amount gave 8 pounds uninjured, and 2½ pounds injured pods. The percentage was, therefore, 76 uninjured and 24 injured pods.

Conclusion

From the above observations it is shown that peanut pods, particularly when still young and soft, are subject to serious injury by the larvæ of the twelve-spotted cucumber beetles (*Diabrotica 12-punctata.*)

That plants in which the pods are matured or maturing rapidly are either free from, or decidedly less injured by the larvæ.

That rotation, and a vigorous growing crop are decided factors in controlling or keeping the crop free from the attack of the larvæ.

As alternates it is considered advisable to cease growing all cereal crops, particularly corn, when rotating with peanuts. Cowpeas, clover, potato, cabbage, spinach, kale, turnips, tobàcco, and eggplants are, so far as known, not subject to larval injury.

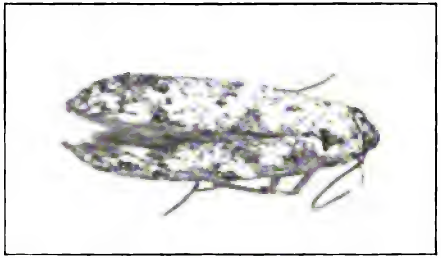

Fig. 1

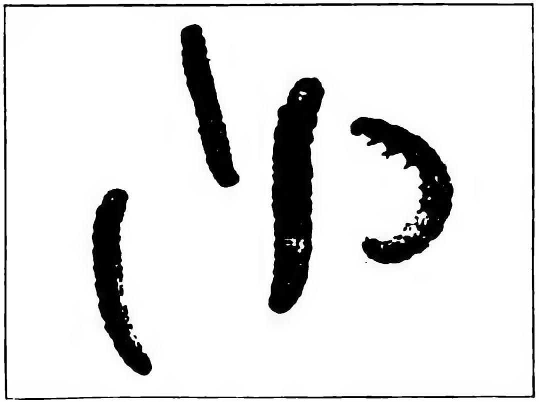

Fig. 2

Fig. 3

A COCCID-FEEDING MOTH

Holcocera iceryæella (Riley) (*Blastobasis iceryæella* Riley)

By E. O. Essig, *University of California, Berkeley, Cal.*

During the summer of 1915 the writer was able to make a number of observations on a coccid-feeding moth which occurs in considerable numbers on the campus of the University of California. This insect was sent to Dr. C. V. Riley who published a description and short report in 1886.[1] During the winter of 1914 Mr. E. P. Van Duzee of the Station Staff called attention to the small hibernating larvæ beneath the old shells of the European peach scale, *Lecanium persicæ* (Fab.). From these caterpillars adults were reared the following spring and forwarded to the Bureau of Entomology, United States Department of Agriculture, Washington, D. C., and were determined by Mr. August Busck.

The caterpillars are small, averaging about 6 mm., but some attain a length of 10 mm. The color is dark reddish-brown with the dorsum noticeably dusky or black. There are several conspicuous narrow whitish lines on the dorsum and the body is covered with numerous short irregular lines of the same color. The tubercles and hairs are also white. Pl. 28. fig. 2 shows the markings fairly well. The prothoracic shield and head are very dark brown or black. The moths average about 9 mm. to the tips of the wings, but the body is only about half as long. The color is ashy-gray due to a mingling of light and dark scales as shown in Pl. 28, fig. 1. Near the middle of the front wings the black scales form an oblique transverse line which is bordered anteriorly by a light-colored line of about the same width. The posterior portions are much darker than the remainder because of the presence of numerous larger black patches. The under surface of the front wings and all of the hind wings are light, the fringes being yellowish. The body is silvery-gray with the posterior part of the abdomen sometimes dusky. The legs and antennæ are light gray with dusky markings.

[1] Report of the Commissioner of Agriculture, pp. 484–486, 1886.

EXPLANATION OF PLATE 28

Fig. 1. Adult of *Holcocera iceryæella* (Riley). Enlarged. (Original. Photo by Dept. Scientific Illustration, Univ. of Cal.)

Fig. 2. Larvæ of *Holcocera iceryæella* (Riley). Enlarged. (Original.)

Fig. 3. Branch of laurel or sweet bay tree, *Laurus nobilis* Linn., showing infestation of greedy scale, *Aspidiotus camelliæ* Sign., and the webs of the larvæ of *Holcocera iceryæella* (Riley).

The exact food habits of the caterpillars are difficult to ascertain and the writer is not sure just how much of the diet consists of the old dead bodies, the waxy scales, etc., and how much of the living coccids. Dr. Riley records the black scale, *Saissetia oleæ* (Bern.) and the cottony cushion or fluted scale, *Icerya purchasi* Mask., as hosts. To this list may be added the European peach scale, *Lecanium persicæ* (Fab.), already referred to, the greedy scale, *Aspidiotus camelliæ* Sign., and Baker's mealy bug, *Pseudococcus bakeri* Essig. Large numbers of the caterpillars were taken from beneath the dead and living scales of the European peach scale and it was apparent that they were feeding upon the dead shells as well as upon the eggs and the young, but there was no evidence of their having devoured more than half-grown scales. The larvæ were found in the greatest numbers upon a laurel or sweet bay tree, *Laurus nobilis* Linn., which was severely infested with the greedy scale, but there was no evidence of their having served as a check to ravages of the scale.

Probably for protection the larvæ spin extensive webs into which are often incorporated bits of leaves, bud scales and other refuse. The webs are often quite compact and may be numerous enough to cover a considerable area. They are to be found in the forks of the limbs, leaf and bud axils, and in fact anywhere the scale insects abound in any considerable numbers. Within or beneath these webs the larvæ live and eventually pupate and do not ordinarily leave them except when one endeavors to remove them by force. They then wriggle exceedingly violently and often escape completely.

Mr. C. J. Pierson, a graduate student of the University succeeded in rearing a number of adults from caterpillars which were taken from the egg masses of Baker's mealy bug.

A HANDY FIELD AND LABORATORY BINOCULAR MAGNIFIER

By R. S. Woglum, *U. S. Bureau of Entomology*

Several years ago while visiting the eminent Coccidologist, Mr. E. Ernest Green, at the Royal Botanical Gardens, Perideniya, Ceylon, the writer's attention was drawn to a simple binocular magnifier adapted for attaching over the eyes. The binocular shown in the accompanying illustration, which was secured from a firm in London, has proved of such value for the observation of insects under conditions requiring low magnification, both in the field as well as in the laboratory, that it has appeared advisable to bring it to the attention of others.

Fig. 20. A handy binocular

The magnification approximates that of the ordinary hand lens, but the flat field produces very little strain to the eyes even when used continuously for an hour or more. In counting or observing such small insects as Coccidæ, in examining plants and seeds, writing small labels, making fine drawings, and the like, the writer's experience has found this magnifier decidedly superior to a hand lens because it requires no manipulation, is less trying to the eyes, and enables the use of both hands.

NOTES ON PEGOMYIA HYOSCYAMI PANZ[1]

By E. N. Cory, *College Park, Md.*

In 1912 the writer found a plant of lamb's-quarters infested by leaf-miners. These were turned over to Mr. A. B. Gahan for rearing. During the spring and early summer of that year additional miners were found by Mr. Gahan and the writer in lamb's-quarters and spinach. Adults were bred from these specimens and determined tentatively as *Pegomyia vicina* Lint. In 1914 the writer began rearing miners from *Chenopodium album,* continuing this work through 1915. A large series was secured by the end of that year.

Specimens of these were submitted to Mr. Knab, of the U. S. National Museum, who determined them as *Pegomyia hyoscyami* Panz., an European species not heretofore recorded from the United States, *Insecutor Inscitiae Menstruus,* Vol. 4, Nos. 1–3, p. 1.

Later upon working over the entire series of specimens reared by Mr. Gahan and the writer from spinach, *Chenopodium album* and *Amarantus retroflexus,* the conclusion was reached that they were all *Pegomyia hyoscyami* Panz.

Meanwhile Mr. Knab had submitted specimens from the series out of *Chenopodium album* to Dr. T. Villeneuve, France, who confirmed his determination of *Pegomyia hyoscyami* Panz.

P. Sorauer in "Handbuch der Pflanzenkrankheiten" places *P. hyoscyami, atriplicis* Gour., *betæ* Curt., *chenopodii* Rond., *conformis* Fall., *dissimilipes* Zett., *spinaciæ* Holmgr. and *vicina* Lint. in synonymy.

The identity of *Pegomyia hyoscyami* Panz. and *P. vicina* Lint. is given in Cameron's paper "A Contribution to a Knowledge of the Belladonna Leaf-miner, *Pegomyia hyoscyami* Panz. Its Life-History and Biology," *Annals of Applied Biology,* Vol. I, No. I, May 1914, pp. 43–77 inclusive.

In this paper Mr. Cameron places in synonymy *P. hyoscyami* Panz., *P. atriplicis* Gour., *P. chenopodii* Rond., *P. conformis* Fall., *P. cunicularis* Rond., *P. effordiens* Rond., *P. egens* Meig., *P. exilis* Meig., *P. gouraldi* R.-D., *P. hæmorrhoa* Panz., *P. betæ* Curt., *P. dissimilipes* Zett., *P. femoralis* Brischke., *P. spinacia* Holmgr. and *P. vicina* Lint.

Stein recognizes the light colored, *hyoscyami* Panz. as the true species and *betæ* Curt. as a darker variety. Several authors agree that the color of the flies depends to a large extent upon the kind and extent of the larval food.

Cameron suggests the possibility of "biologic" species within the

[1] Contribution from the Maryland Agricultural Experiment Station.

limits of a single polyphagous species. The fact that he was unable to get adults bred from belladonna to oviposit on mangold leaves and vice versa has led him to question the statement that insects often oviposit on a number of related plants. His experiments, showing a preferential selection of food plants, lead him to the belief that slight variations, such as in color, may arise from the adoption of preferences.

Flies bred from Chenopodiaceæ (*Spinacia oleracea* and *Chenopodium album*) and from Amarantaceæ (*Amarantus retroflexus*) do not show any differences in color that would warrant the separation of varieties, out of the series at hand.

The entire series bred by Mr. A. B. Gahan and the writer from the above named host plants has been carefully gone over by Mr. Knab. The specimens in the U. S. National Museum and two specimens from Wooster, Ohio, in the possession of Mr. Gahan, all labelled *P. vicina* Lint., have been compared with this series. Without doubt they are all the same species, *P. hyoscyami* Panz.

Seasonal History

The first record of eggs found is May 15, 1915. These eggs were on *Chenopodium album*. Three masses of 3, 4, and 4 eggs, respectively, were found.

Nearly full grown larvæ were found on May 17, 1912, in spinach leaves. These produced adults on June 5, 6, 7, 12, 15 and 19.

From May 15 to the first week in August the miners are readily found in lamb's-quarters. After that time they disappeared until September when a new brood appeared.

Repeated efforts to get the adults to breed in confinement have failed and so no definite records were obtainable on the number of broods. The straggling emergence of adults indicates a considerable overlapping of broods. However, there are certainly three broods during the season with a probability of the existence of at least one more brood.

The Egg

The egg is .72 mm. x .26 mm., nearly cylindrical, white and heavily reticulated. They are deposited in rather regular rows on the under surface of the leaves. The greatest number observed on a single leaf was eight. Generally three or four is the usual number. The time from the deposition of the egg to its hatching approximately is four days.

The Larva

The larva is nearly cylindrical in cross section. It tapers to the anterior end when stretched out, but in life the tapering is only slightly

noticeable. The heavily chitinized mouthparts are visible through the translucent glossy, greenish white integument. Length 6–7 mm. This stage requires 15 to 17 days. Three larval instars may be noted. The larvæ are capable of reëntering the leaves after being removed from their burrows. When the entire parenchymatous tissue of a leaf is consumed, before the larva reaches its full development, it migrates to another leaf.

The "rake" or "great hooks" consist of two arms attached to a bifid basal piece. The mandibular sclerites bear four teeth each (Fig. 21*a*).

The anterior spiracles have eight lobes opening on the margins of a fan-shaped prominence (Fig. 21*b*).

The posterior stigmatal areas are rather widely separated and each spiracle bears three stigmata arranged as in Fig. 21*c*.

The structural details from the author's specimens agree exactly with the description of *P. hyoscyami* Panz. of Cameron but not with his figures and agree almost exactly with the Riley figures of *P. vicina* Lint., *Insect Life*, Vol. 7, p. 380.

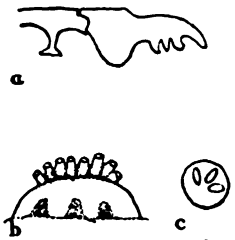

Fig. 21. *Pegomyia hyoscyami*, *a* great hooks, *b* anterior spiracle, *c* posterior stigmatal area

The Puparium

The pupa is nearly cylindrical, obtusely rounded at both ends. Color light chestnut brown when first formed, changing to darker brown just before emergence. The anterior spiracles rise in fan shape from rounded rugose bases. The posterior spiracles are slightly raised on globular bases. Between the stigmatal areas are three heavy ridges converging ventrally. The longest pupal stage observed occupied 20 days, the shortest 14 days with all graduations in between these extremes.

The Adult

The adults bred here agree in all essentials with the descriptions of Stein, and Meade, as given by Lintner, with the correction noted by Sirrine in Bul. 99, N. Y. Agricultural Experiment Station.

The coloration varies in the series in individuals from the same host plant. There are no constant color changes in the series from different hosts.

The chief point of doubt as to the identity of specimens may be due to collapse of specimens killed too soon. Such specimens often have the frontal stripe obscured by the orbits becoming approximated; especially is this true in the males.

The entire life occupies 30 days as its shortest period. The longest period covered 42 days. An average of 32 days is correct for the majority of cases.

Parasites

The only parasite bred from *Pegomyia hyoscyami* Panz. is *Opius foveolatus* Ashm.[1] This species has been bred from nearly every lot of miners but never in sufficient numbers to indicate that it might be an important factor in the control of the miner.

Control

On weeds such as Chenopodium and Amarantus no effort has been made to control the miners and the miners have not appeared on spinach since 1912. In this connection it might be well, however, to cite the work of Vassiliev, "Report of the Work of the Experimental Entomological Station of the All-Russian Society of Sugar Refiners in 1913," Kiev. 1914; abstracts in *Review of Applied Entomology*, Vol. II, No. 7, Ser. A., p. 467. He has used a solution of barium chloride in 5, 6, and 7 per cent solutions with excellent control of the miners in beet leaves.

COST OF DUSTING AND SPRAYING A NEW YORK APPLE ORCHARD

By C. R. Crosby

There is very little information available in regard to the comparative cost of dusting and spraying an apple orchard under commercial conditions. On January 15, 1916, Mr. W. A. Crandall of Kendall, N. Y., read a paper before the Orleans County Fruit Growers' Association at Albion, N. Y., in which the following facts were presented. Mr. Crandall has an orchard of about twenty-one acres containing about 625 trees, ranging in age from thirty-five to forty years, mostly Baldwins, Russets and Greenings with a few odd varieties. This orchard was sprayed in 1913 and 1914 and dusted in 1915. The owner has kept a careful record of the expense as indicated in the following table. Each year three applications were made; the first when the blossoms showed pink, the second as the last of the petals were falling and the third in August.

[1] Determined by Mr. A. B. Gahan.

Cost of Spraying Orchard in 1913

Time of Application	May 4	May 14	Aug. 14	Total	Cost
Gallons of spray material........	1,400	5,000	2,200	8,600	$60.80
Man, hours....................	43.5	116.5	86	246	49.20
Horse, hours...................	26	73	84	183	23.79
Equipment, hours..............	26	73	84	183	20.05
					$153.84

In 1913 the crop was 1,183 barrels. The spray materials consisted of lime-sulfur and arsenate of lead.

Cost of Spraying Orchard in 1914

Time of Application	May 19	May 26	Aug. 1.	Total	Cost
Gallons spray material..........	3,000	4,000	4,000	11,000	$64.80
Man, hours....................	85	90	99	274	54.80
Horse, hours...................	47	47	63	157	20.41
Equipment, hours..............	47	47	63	157	18.06
					$158.07

In 1914 the crop was 1,653 barrels. The spray material used consisted of lime-sulfur and arsenate of lead.

Cost of Dusting Orchard in 1915

Time of Application	May 4	May 19	Aug. 18	Total	Cost
Pounds of dust.................	670	885	475	2,030	$88.50
Man, hours....................	13.5	14	11.5	39	7.80
Horse, hours...................	13.5	15	11.5	40	5.20
Equipment, hours..............	13.5	15	11.5	40	4.60
					$106.10

In 1915 the crop was 885 barrels. The dust mixture used consisted of 90 per cent finely ground sulfur and 10 per cent arsenate of lead.

From the above tables it will be seen that the cost of dusting the orchard in 1915 was $47.74 less than the cost of spraying it in 1913, and $51.97 less than spraying it in 1914.

In 1915 the whole orchard was dusted and there was no opportunity of comparing the relative efficiency of the different methods of applying the materials. Extensive observations as to the relative efficiency of dusting and spraying have been published in bulletins 340, 354, and 369 of the Cornell University Agricultural Experiment Station.

Scientific Notes

An Egg Parasite of the Army-worm (*Heliophila unipuncta*). During the late spring of 1914 a severe outbreak of the army-worm (*Heliophila unipuncta*) occurred in many places in southern and central Illinois. Notwithstanding the fact that many of the worms were killed by insect enemies and diseases, large numbers completed their growth, and the moths were very abundant by the middle of June. During the latter part of June and the first part of July, careful watch was kept of grass-lands and lawns in the central part of Illinois for the appearance of the second generation of the worms, but only a very few were found.

In another part of the state, moths of this species were very abundant during the last two weeks of October, 1914. Thousands of them were seen in the early evenings around piles of cull apples in orchards, and in one case thirty-five were counted on a single rotten apple. In the spring of 1915, however, it was hard to find army-worms in this section; and it seemed probable that some egg-parasite might be keeping the species in check.

In the middle of July, 1915, army-worm moths again became abundant in the vicinity of Springfield, Ill., and on each of several evenings nearly a hundred were caught in a small fly-trap. July 24, six pairs of these moths were placed in a lantern-chimney cage over a six-inch pot containing a plant of crab-grass. July 26 this grass was found to be well stocked with eggs, and the adults were killed, the chimney was removed, and the pot containing the grass was set outside the insectary on a lawn where large numbers of army-worm moths had been noticed for several nights previous. The pot was left here until the morning of July 28, when several of the eggs were removed and placed in small shell-vials tightly stopped with cotton. August 3 several army-worms hatched, and August 13 a small Chalcid was noticed in one of the vials. On the next day a number of these Chalcids were seen emerging from the army-worm eggs; and an examination made several days later showed that 79 per cent of the eggs had been parasitized. A large series of experiments was at once started to determine the general abundance of this egg-parasite; but a little later all were accidentally destroyed.

Specimens of this Chalcid were identified by Mr. J. C. Crawford as belonging to the genus *Telenomus*, but whether or not they represent a new species he was not then prepared to say.

As the army-worm moth is nearly always common in the summer and fall months, it seems probable that this new egg-parasite may have a powerful influence in restricting the increase of this pest and in bringing sudden outbreaks to a conclusion.

WESLEY P. FLINT.

State Entomologist's Office, Urbana, Ill.,
March 30, 1916.

Cause of Death of a Valuable Animal During Fumigation with Nitrobenzene. At the Columbus meetings of the Association of Economic Entomologists, Professor William Moore presented a valuable and suggestive paper on the fumigation of animals with nitrobenzene, for the purpose of ridding them of their ecto-parasites.[1] On our return to Ithaca, Mr. W. L. Chandler and I decided to check over and use this method on the animals we were using in our laboratory work, and whenever opportunity arose.

In the course of the work, after many favorable experiments, a valuable hunting dog was being fumigated for fleas. In that respect the experiment was a great success for when I saw the dog nearly a half hour after he was exposed, the fleas were literally falling off from him. Less than an hour later he was dead, all attempts to

[1]JOUR. EC. ENT., Feb. 1916, IX, p. 71–78.

revive him having proved futile. Unfortunately for the completeness of the data, he was not under observation during this period. The fumigant had been used so frequently without any untoward results, both by Professor Moore and ourselves, that nothing of the sort was anticipated.

An autopsy was held, not only for the purpose of noting any possible effects of the gas but because we expected to find that the death of the animal was due to the bursting of a blood-vessel or similar injury, during some unnoted struggle. Nothing of the sort was found. In fact, there was not the slightest trace of inflammation which could have been attributed to the effect of the gas.

On the other hand, we found between the liver and the diaphragm, two specimens of the giant nematode, *Dioctophyme renale* (*Eustrongylus gigas*). The liver tissue in their immediate neighborhood was diseased, the entire inner face of the diaphragm was festooned with an organized exudate, and there was a general, acute peritonitis. Mr. Chandler and I shall present a more detailed report of these conditions elsewhere.

It is sufficient to say here that the real cause of the death of the animal was the presence of the parasites. Nevertheless, the experience served to emphasize what I pointed out at the time the paper was first presented. We need additional data regarding the effect of the gas under different physical conditions of the animals and even when that is known, we may have to allow for individual idiosyncrasies. For the present, experimenters may find it advisable to use less valuable animals than our victim.

Wm. A. Riley,
Cornell University.

Gonepteryx rhamni Linn. and Castnia therapon Koll. in New Jersey. *Gonepteryx rhamni* Linn. (Lep.). An almost perfect female of this species, known as the Brimstone Butterfly, was taken at Rutherford, N. J., during the early part of December, 1915, from a case of French shrubs. It had evidently emerged on the way over, probably only a short time before the box was unpacked, as it was in a fairly fresh condition. W. F. Kirby in "European Butterflies and Moths" states that "the butterfly abounds in and near woods in most parts of Europe, Asia and North Africa . . . common in the south of England . . . unknown in Scotland . . . and the only certain locality in Ireland is Killarney." Seitz, in "Macrolepidoptera of the World, Palearctic Butterflies," Vol. I, p. 60, figures a male and female and states that "it inhabits the whole Palearctic Region with the exception of most northern districts and the Canaries, occurring also in North India as a slightly modified local form." The larva feeds on buckthorn from May to July. The female found in the French stock was taken from a bundle of *Cotoneaster microphilla* which is also a thorny shrub. *Castnia therapon* Koll. (Lep.). During January, 1916, orchids growing in a greenhouse at Bound Brook, N. J., were found to be infested by a lepidopterous larva which bored through the rhizome and up into the bulb, doing, of course, considerable damage. The greenhouse man was interested enough to save two pupæ which he found in the infested plants, from which later emerged specimens of *Castnia therapon* Koll. (identified by Mr. F. E. Watson). A brief account of this insect together with a figure can be found in Seitz's Macrolepidoptera of the World (Vol. VI, p. 12, plate 7, a) which gives Brazil as its native home and *Oncidium crispum* and *Catasetum* sp., as food plants. An additional species of orchid can now be listed, namely *Cattleya labiata*, this being the plant found infested at Bound Brook. These orchids came originally from Pernambuco and were undoubtedly infested at the time of their arrival. This insect occurs also in other New Jersey orchid houses but in a very limited way.

Harry B. Weiss,
New Brunswick, N. J.

Report of the Finding of American Foulbrood and European Foulbrood in the Same Bee Comb. In the examination of about five thousand suspected samples of bee comb and brood from every section of the United States and several foreign countries, the writer has never until recently observed both American foulbrood and European foulbrood in the same comb. The sample referred to is No. 4982, from Patterson, Stanislaus County, California, sent to the Bureau of Entomology by Mr. Willis Lynch, County Apiary Inspector, Stockton, California, and diagnosed in the Bureau Laboratory May 4, 1916.

The presence of American foulbrood is exhibited by many typical scales closely adhering to the lower cell wall and showing, on microscopical examination, numerous spores suggesting *Bacillus larvæ*, the identity of which is further confirmed by the fact that they fail to grow on the ordinary media of the laboratory. The odor is definite and characteristic for American foulbrood but, as is sometimes also the case where American foulbrood occurs alone, not pronounced.

The presence of European foulbrood is exhibited by many larvæ of grey, yellow, and brown coloration, lying at the bottom of the cell, and presenting the melting appearance often noted in larvæ affected with this disease. These larvæ showed, on microscopical examination, *Bacillus pluton* in large number. Spores of *Bacillus alvei* were also found in large number in some of these larvæ.

No larvæ in the ropy stage of American foulbrood were found—only the dry adherent scales, while fresh, moist, melting larvæ of European foulbrood were present, indicating an active condition of the last mentioned disease. If the sample is representative of all of the affected larvæ in the colony, it seems probable that American foulbrood attacked the colony first; the scales may have been in the comb since last year or even longer. However, the priority of either disease is a matter of speculation without a complete history of the colony itself.

Mr. Lynch states that several years ago American foulbrood was found about ten miles south of Patterson, and that in the latter part of 1915 the same disease manifested itself near the apiary, from which the sample was taken. European foulbrood, Mr. Lynch further states, broke out very badly about fifteen miles north of Patterson in July 1914 and moved up the San Joaquin river towards Patterson. All who saw this outbreak made a gross diagnosis of both diseases; viz—American foulbrood and European foulbrood. This history relative to the appearance of these two diseases in the vicinity, from which the sample was taken, is interesting as showing clearly that American foulbrood was first in evidence, according to gross or field diagnosis. This is no evidence, however, that American foulbrood was the first disease to make its appearance in the colony from which sample No. 4982 was taken, but it seems not unlikely.

Beekeepers have from time to time sent in samples with the report that both diseases were present in the same comb but they have all proven on laboratory examination to be one or the other disease alone.

So far as the writer is aware, this is only the second authentic report confirmed by laboratory findings of the presence of these two diseases in the same comb.

ARTHUR H. McCRAY, M.D.,
Apicultural Assistant, Bureau of Entomology.

// JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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This issue, with two detailed studies of the bionomics of *Musca domestica*, may well be characterized as our house-fly number. It is hardly to be expected that the matter relating to this insect will be accepted without question and if a vigorous skepticism is aroused and others are spurred on to solve problems of practical importance in control work, so much the better. There is no question but that more attention should be paid to the chemotropic and phototropic reactions of both adults and larvæ since limitations along these lines suggest some of the most promising methods for the control work of the future.

The hibernation of this insect, especially under conditions obtaining in the northern United States, is another matter worthy of careful investigation, and it is surprising that the method or methods of wintering have not been carefully worked out in several representative localities, since the common belief that the insect hibernated as an adult has been questioned for several years.

There appears in this issue a brief record of untoward results following the use of a comparatively untried insecticide. The autopsy disclosed unsuspected pathological conditions which were responsible for the death of the animal. It is only another case emphasizing the desirability of exhaustive tests before there are unqualified recommendations, and the incident itself suggests the ease with which totally erroneus conclusions may be drawn.

Reviews

Ticks, a Monograph of the Ixodoidea, by G. H. F. NUTTALL, C. WARBURTON, W. F. COOPER, and L. E. ROBINSON. Cambridge University Press, Part III, pages XIII+349–550. October, 1915.

This third part of the monograph of the ticks is under the authorship of Doctor Nuttall and Professor Warburton and deals with the genus Hæmaphysalis. As a companion fascicle has appeared Part II, of the bibliography of ticks by G. H. F. Nuttall and L. E. Robinson, containing a total of 462 titles. Part I of the monograph (Argasidæ) was published in 1908 and Part II (Ixodidæ) in 1911. The same general plan of treatment is followed as in the numbers already issued, and the present part is up to the high standard set by the portions of the work already in print. This number is well illustrated, containing six plates and 144 text figures. The plates are reproduced from former illustrations of the authors. One-half of the text figures are new. The authors recognize forty-two species and eight varieties in this genus. No new species are included, but a number of those rather poorly described previously are more fully characterized, and a considerable number of larvæ and nymphs are described for the first time.

The genus Hæmaphysalis is one of comparatively small economic importance; however, we find by going over the host lists as presented by the authors that nineteen species and three varieties have been found upon domestic animals, and four species have been taken on poultry. Two species of this genus have been proved to carry disease. One of these, *H. leachi*, acts as the chief vector of *Piroplasma canis* which produces a very fatal disease of dogs in Africa, known as malignant jaundice. The other, *H. cinnabarina* var. *punctata*, has been shown to be capable of transmitting British redwater, the causative organism of which is known as *P. divergens*. The part played by this tick in transmitting this disease is probably a minor one, as *Ixodes ricinus* has been shown to be the principal carrier. It is interesting to note in this connection that the authors consider *H. chordeilis* (Packard 1869) to be identical with Koch's *H. cinnabarina* described from Brazil, thus suppressing a name which is familiar to American workers in this group. They have also concluded that the above mentioned form (*punctata*) is merely a variety of *H. cinnabarina*.

Only two species of the genus occur in the United States, these being *H. cinnabarina* (*H. chordeilis*), and *H. leporis-palustris*, the common rabbit tick. The former of these species, together with its European variety *punctata*, is the most widely distributed tick of the genus. A valuable list showing the distribution and hosts of the various species of the genus is given, and a good summary of what is known of the biologies of species of this genus is included. The life-histories of six species have been more or less completely worked out. The authors add some new biological records to those already published by themselves and various other workers, and unpublished notes by Doctor Brumpt of Paris on *H. concinna* and *H. inermis* are included. The latter species exhibits certain biological traits unique among the ixodid ticks. The female deposits comparatively few eggs (about 200), and the time required for larvæ and nymphs to engorge is exceptionally short, ranging from one and one-half to three hours in the former and one to two hours in the latter.

The fact is significant that only fourteen out of the total of fifty species and varieties recognized by the authors are known in all four of their stages. Further, it may be mentioned that but nineteen species and varieties are known in the nymphal stage and fourteen in the larval stage, and but one sex has been discovered in thirteen of the species and varieties.

The authors are to be congratulated on the fact that they have produced the present commendable fascicle under such trying conditions and that they are proceeding with the other parts of the monograph as rapidly as possible. It is hoped that American investigators will assist in this valuable work as far as possible by purchasing parts of the monograph already issued, since it is understood the expense of publication is now, in part at least, falling upon the authors.

F. C. Bishopp.

April 1, 1916.

Reports on Scale Insects, by J. H. Comstock. Cornell University, Bulletin 372, p. 603. 1916.

This is a reprint of the epoch-making papers on the Coccidæ published originally in the reports of the Entomologist of the United States Department of Agriculture and in the Second Report of the Cornell University Agricultural Experiment Station. These contributions to knowledge are so well known that a review is unnecessary. They are indispensible to any student working on the Coccidæ and it is by all means desirable that they should be in a readily available form. The publication also serves to emphasize the practical value and importance of one of the earlier contributions by a beloved teacher and investigator in both economic and systematic entomology (*Advertisement*).

Typical Flies, a Photographic Atlas of Diptera, Including Aphaniptera, by E. K. Pearce. Cambridge University Press, p. 1–48. 1915.

This small volume contains over 150 very satisfactory process reproductions of typical flies and is designed to encourage the beginner in the study of a group worthy of much more attention than has been given it by entomologists, though the last few years has witnessed a gratifying increase in dipterological studies. Each figure is accompanied by more than the usual elucidatory matter and there is an excellent index. The volume, a very good substitute for a small collection of representative species, may be procured through G. P. Putnam's Sons for $1.50 (*Advertisement*).

Minnesota State Entomologists' Reports, Index, by O. J. Wenzel. Circular No. 38, p. 1–40. 1916.

This detailed index, preceded by a list of the reports and bulletins and with an appendix listing the other publications of the State Entomologist and the Division of Entomology, University of Minnesota, will greatly facilitate reference to this excellent series of publications begun over twenty years ago by Otto Lugger and continued in a highly successful manner by the present incumbent. Entomologists may obtain this circular on application (*Advertisement*).

Current Notes

Conducted by the Associate Editor

Mr. J. P. Ivy is the State Apiary Inspector of Arizona.

Mr. D. L. Van Dine, Bureau of Entomology, has gone to Mound, La., to resume his work on malaria mosquitoes.

Mr. F. C. Bishopp, Bureau of Entomology, who underwent a surgical operation in February, is now on active duty.

Dr. C. Gordon Hewitt, Dominion Entomologist, of Ottawa, Canada, visited the Bureau of Entomology on March 16.

Dr. E. F. Phillips, of the Bureau of Entomology, addressed the New York Farmers on April 4 at their annual dinner in New York City.

Dr. Back, Bureau of Entomology, has returned to Washington and is engaged in writing up his general report on the Mediterranean fruit-fly.

The death of Thomas H. Cunningham, Inspector of Fruit Pests for British Columbia, occured February 16th. (*Canadian Entomologist*).

Dr. L. O. Howard has recently been elected a member of the National Academy of Sciences and President of the Washington Academy of Sciences.

Mr. Geoffrey Meade-Waldo, the author of many papers on the Hymenoptera, and for some time connected with the British Museum, died March 11.

Mr. George S. Demuth, Bureau of Entomology, attended the meeting of the Pennsylvania State Bee-Keepers' Association at Lancaster on March 3–4.

Mr. C. Joseph Manter of California has been appointed field assistant of the Bureau of Entomology for work in that state on sugar-beet and truck-crop insects.

Mr. Harold L. Weatherby of Alabama has been appointed field assistant in the Bureau of Entomology, for work at Rocky Ford, Colo., where he was employed a few years ago.

Mr. B. R. Leach, Bureau of Entomology, has returned to his permanent headquarters at Winchester, Va., where he will continue his investigations of the woolly apple aphis.

Messrs. G. H. Cowan and M. S. Stanley have been appointed temporary field assistants, Bureau of Entomology, in connection with the work on the Rocky Mountain spotted-fever tick.

Mr. A. J. Ackermann, Bureau of Entomology, has been in Washington for a few weeks preparing his notes on the subject of nursery insects, and has now returned to his headquarters at West Chester, Pa.

Mr. H. B. Scammell, Bureau of Entomology, in charge of the laboratory at Brown Mills, N. J., spent a few days in Washington and has now returned to his headquarters to resume his studies of cranberry insects.

Mr. J. G. Hester, Bureau of Entomology, who assisted Mr. M. M. High in his work on onion insects and truck-crop pests last year, has been reappointed and will resume work at Brownsville, Texas, and vicinity.

Mr. W. F. Fiske, who has been in British East Africa for some time in the investigation of the bionomics of Tsetse flies for the Imperial Bureau of Entomology, has returned to England by way of Khartum and Cairo.

Mr. E. H. Siegler, Bureau of Entomology, who has been in Washington for the past few months, has now returned to his field headquarters at Grand Junction, Colo., where he is engaged in codling moth investigations.

Dr. E. D. Ball has resigned as Director of the Utah Agricultural Experiment Station, and hopes to soon take up entomological work again. Unless a good opening occurs, he will probably spend a year in graduate study.

Mr. W. V. King, Bureau of Entomology, is now at Florence, Mont., where he will have charge of the Bureau's work on the eradication of the spotted-fever tick. He will return to Louisiana sometime during the summer.

Mr. Charles E. Smith, Bureau of Entomology, who has had experience in investigation of insects injurious to truck crops at Baton Rouge, La., has been reappointed to assist Thomas H. Jones at the Baton Rouge station.

Mr. C. F. Turner, Bureau of Entomology, who has been stationed temporarily at Hagerstown, Md., for the purpose of conducting some histological and biological studies, will shortly return to his field station at Greenwood, Miss.

The field station formerly conducted by the branch of Cereal and Forage Insect Investigations, Bureau of Entomology, at Nashville, Tenn., has been moved to Knoxville. The post office address is R. F. D. No. 9, Knoxville, Tenn.

Mr. E. W. Geyer, Bureau of Entomology, formerly in charge of the laboratory at Roswell, N. M., has severed his connection with the Bureau and Mr. R. J. Fiske is now in charge of this laboratory and is engaged in codling moth investigations.

Mr. P. R. Myers, of the Hagerstown, Md., laboratory, Bureau of Entomology, recently visited Washington for the purpose of consulting the collections of the U. S. National Museum in connection with investigations of the parasites of the Hessian fly.

Mr. W. F. Turner, who has been assisting Mr. A. C. Baker at Vienna, Va., in life-history studies of plant lice, resigned from the Bureau of Entomology to accept appointment with the Georgia State Entomologist, with headquarters at Thomasville, Ga.

Mr. H. K. Plank, Bureau of Entomology, who has been assisting Mr. Scammell in cranberry insect investigations in New Jersey, has been transferred to the laboratory at Grand Junction, Colo., where he will assist Mr. Siegler in codling moth investigations.

The Secretary for Agriculture and Industries of British Columbia has issued a regulation under date of March 23, 1916, requiring that all bees entering the province be accompanied by a certificate vouching for their freedom from infectious brood diseases.

Mr. D. Isely, Bureau of Entomology, who has been in Washington preparing his notes on grape-insect investigations, has returned to the field for the purpose of resuming investigations of the grape-berry moth and other grape insects at North East, Pa.

In Palmer Park and North Cheyenne Canyon, within a short distance of Colorado Springs, Colo., Mr. George Hofer, Bureau of Entomology, will make a study of *Agrilus acutipennis* var., in relation to the dying of oak trees within the City and Mountain Parks.

Mr. H. Yuasa, a graduate student and graduate assistant in the Department of Entomology, Kansas State Agricultural College, will continue his graduate work in the Department of Entomology of the University of Illinois, where he has received a graduate scholarship.

The "green bug" outlook for Texas, Oklahoma and Kansas is considerably improved over the conditions of last fall. However, there is still a possibility of a serious infestation of this insect during the coming spring, providing meteorological conditions prove favorable.

Mr. T. H. Parks, formerly extension entomologist of Idaho, and for several years entomological assistant in the Bureau of Entomology, has been appointed extension entomologist of the Kansas State Agricultural College. Mr. Parks began his work in Kansas the middle of March.

Mr. A. C. Baker, Bureau of Entomology, who has been engaged in life-history studies of plant lice, with headquarters at Vienna, Va., has been transferred to Washington, D. C., as permanent headquarters, where he will continue life-history studies of plant lice and systematic work with Aphididæ.

According to *Science*, Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D. C., and Professor Antonio Berlese of Rome, have been elected honorary fellows of the Entomological Society of London, to fill vacancies caused by the deaths of J. H. Fabre and Brunner von Wattenwyl.

Mr. R. B. Ellis, who has studied entomology at the Agricultural College at Manhattan, Kan., has been engaged by the Bureau of Entomology, to assist in work on insects injurious to sugar beets and truck crops at Wichita, Kan., where Mr. F. B. Milliken is in charge of the local station.

Mr. B. L. Boyden, Bureau of Entomology, who has been engaged in experimental work on the sugar-beet wireworms and other insects injurious to sugar beet, beans, and other truck crops at Oxnard, Cal., has taken permanent headquarters at Pasadena, Cal., the Oxnard station remaining as a substation.

Mr. George S. Demuth, Bureau of Entomology, will leave soon for Winchester, Va., to resume the work on the effect on bees of spraying fruit trees, in coöperation with the Office of Deciduous Fruit Insect Investigations. The work will also probably be continued at a more northern point at a later date.

Mr. S. L. Mason has been appointed as scientific assistant in the Bureau of Entomology and detailed to assist Mr. John J. Davis at the West Lafayette, Ind., field station. Mr. Mason takes the place of Mr. Daniel G. Tower, who has been transferred to the Tropical and Subtropical Fruit Insect Investigations.

Mr. E. B. Blakeslee, Bureau of Entomology, who has been in Washington preparing notes on the subject of his field investigations, has returned to the field to resume his investigations of peach insects and will spend a good deal of his time this season in the neighborhood of Springfield, W. Va., investigating the peach-tree borer.

Mr. W. W. Yothers, Bureau of Entomology, is about to take up a new phase of the citrus insect problem of Florida, namely, a study of the insects and insect control in relation to the extensive culture of limes on the Florida Keys. Mr. Yothers has been requested to submit a detailed project plan of this work for approval.

The field station of the Bureau of Entomology at Batesburg, S. C., which has been in operation for several years, has been discontinued. Mr. E. A. McGregor, who was in charge, has been detailed to work on cotton insects in the Imperial Valley of California. Mr. F. L. McDonough is now stationed at Quincy, Fla., on work with tobacco insects.

Information has been received from Mr. M. M. High, Brownsville, Texas, and from Prof. F. W. Mally, County Agent, Laredo, Texas, that a considerable acreage of onions and garlic have been saved from the ravages of the onion thrips by the control measures advised by the Bureau of Entomology at Mission, Mercedes, Harlingen, Laredo and Brownsville.

Mr. George F. Moznette, formerly instructor, has been appointed Assistant Professor in Entomology at the Oregon Agricultural College and Station, and began his duties March 1. Mr. Moznette has just completed a year's advanced work in Entomology at the University of California at Berkeley and will be engaged in research problems at the Oregon Station.

Mr. J. R. Horton, Bureau of Entomology, has closed up his station at New Orleans and has left for Southern California to study the Argentine ant as affected by Pacific Coast conditions. He will do this work in coöperation with Mr. Woglum at the Pasadena Station. The California end of this investigation will probably be completed within two or three months.

At the Southern Rocky Mountain Station, Bureau of Entomology, Colorado Springs, Colo., a camp was established on March 7 on the east slope of Pike's Peak, at an altitude of 9,500 feet. From this station special studies will be made by Mr. J. H. Pollock on the "Relation of Altitude to the Periodical Phenomena of Insects," along with other special and general projects.

Mr. H. G. Ingerson, Bureau of Entomology, who has been assisting Mr. Simanton at Benton Harbor, Mich., in connection with orchard-insecticide and spraying-machinery investigations, after spending some little time in Washington in the preparation of his field notes, has now returned to the field for the purpose of undertaking investigations of the grape-berry moth and other grape insects in northern Ohio.

Mr. N. F. Howard, Bureau of Entomology, who was engaged during the past summer in work on the root-maggots and other insects injurious to onion and cruciferous crops at Green Bay, Wis., and who has been studying for a Master's and Doctor's degree at the Ohio State University, has been engaged to continue the work begun at that Station, and also to investigate insects as carriers of pickle diseases.

As a result of experiments carried on by the branch of Cereal and Forest Insect Investigations, Bureau of Entomology, during the past winter, it has been determined that *Laphygma frugiperda* S & A. wintered over in the pupal and larval stages as far north as northern Florida and central Texas but failed to do so in Oklahoma. The results in wintering-over experiments have not yet been secured for Kansas, Georgia and South Carolina.

Dr. W. M. Wheeler of the Bussey Institution, in attendance at the meeting of the National Academy at Washington, April 17–19, spent part of a day in the U. S. National Museum studying the collection of ants left by the late Theo. Pergande. Mr. Pergande's entire collection has been given to the Museum by his daughter. The ants are in good condition, but many of the insects of the other orders have been uncared for in late years and badly eaten by Dermestids.

A new and important project of the Bureau of Entomology for the coming year will be an investigation in coöperation with the Bureau of Plant Industry of insects as carriers of mosaic and other diseases of cucumbers and other cucurbits with special reference to the pickle industry of the states of Wisconsin, Michigan and Indiana.

The principal insects which act as disseminators of these diseases are the striped and twelve-spotted cucumber beetles and the tarnished plant-bug, while other insects are under suspicion.

In Waldo Canyon, within the Pike National Forest, Colorado, at an altitude of 7,500 feet, an outdoor cage will be constructed surrounding and covering the main trunk of a 20-inch diameter yellow pine tree, infested by *Dendroctonus ponderosæ* Hopk. The butt cut will be left intact and other sections stood up within the cage. A study will be made by Messrs. W. D. Edmonston and George Hofer, Bureau of Entomology, of the flight habits of this important tree destroyer. Other infested trees in close proximity will also be utilized for study.

The fig moth (*Ephestia cautella* Walk.) has been reported to the Bureau of Entomology by Mr. M. M. High as occurring in new material. Moths have been reared from Kafir corn and cowpeas, and also in alfalfa meal. This species has been treated in detail in Bulletin 104, a list of food plants being given on page 19. It is one of the several species of insects which have been found injuring cork in the heads of pop bottles. We have also received specimens through the Federal Horticultural Board occurring in yeheb nuts from Arabia.

The broad-bean weevil, *Laria rufimana* Boh. (Bulletin 96, Part V, Bureau of Entomology), has recently been ascertained to have a positive alternate food plant in the garden pea. Numerous specimens were obtained in peas from Paris, France. Thus far we have not received notice of this insect occurring in peas on the Pacific Coast and agents of the Bureau and correspondents in California are urgently requested to keep a lookout for it. The discovery of this new food plant will probably render it impossible to stamp out the pest in the few regions where broad or Windsor beans are grown, and which it is now known to infest.

During the month it transpired that the British Steamship *Appam*, brought to Norfolk, Va., as a German prize of war, had about two hundred tons of cotton seed from West Africa as a part of its cargo. Messrs. Marlatt and Hunter of the Federal Horticultural Board visited Norfolk and Newport News in connection with the disposition of this seed, which was found to be infested by the pink bollworm, *Gelechia gossypiella*. A provisional sale of the seed by the Admiralty Court to an oil-mill in North Carolina was set aside when the danger was explained. Arrangements were immediately made for placing the entire lot in sulphuric-acid vats as a preliminary to the conversion of the seed into fertilizer. As an additional precaution the holds of the *Appam* were fumigated with hydrocyanic-acid gas under the supervision of Mr. Morrison.

The following changes in titles, rendering the designations of the heads of offices more compatible with their specialized lines of work, are herewith announced:

C. L. Marlatt, Entomologist and Assistant Chief of Bureau.

W. D. Hunter, Entomologist in Charge Southern Field Crop Insect Investigations.

A. L. Quaintance, Entomologist in Charge Deciduous Fruit Insect Investigations.

F. H. Chittenden, Entomologist in Charge Truck Crop and Stored Product Insect Investigations.

A. F. Burgess, Entomologist in Charge Preventing Spread of Moths.

E. F. Phillips, Apiculturist.

L. H. Worthley, Agent, Preventing Spread of Moths.

G. F. White, Expert, Apicultural Investigations.

E. A. Back, Entomologist, Mediterranean and Other Fruit-Fly Investigations.

W. D. Pierce, Entomologist, Southern Field Crop Insect Investigations.
N. E. McIndoo, Insect Physiologist, Deciduous Fruit Insect Investigations.
A. T. Speare, Myco-entomologist, Deciduous Fruit Insect Investigations.

It will be of interest to entomologists to know that the cotton fumigating plants in Boston, constructed by the Bureau of Entomology, are now in active operation. Over 1,200 bales of cotton have already been fumigated in the two plants now available. These plants, furthermore, are being rapidly enlarged so that ultimately their capacity will be approximately 1,000 bales a day each. It is very satisfactory to know that these plants are in successful operation, inasmuch as this large-scale work has been hitherto on a somewhat theoretical basis. As previously noted, this work represents the largest insect fumigating plants which the world has ever seen, and undoubtedly very much the largest investment ever made for this purpose. It is reported that the fumigation plant at Oakland, Cal., to meet the needs of the port of San Francisco, is again in readiness. In common with one of the plants in Boston, this Oakland plant had a breakdown, not having originally been made strong enough to stand the vacuum pressure. A similar plant is in process of construction at Newark, N. J., and probably before long there will be a plant of the same kind available in New York City. Plants at other ports are also being contemplated. These are all private concerns, and make a regular charge for disinfection.

S. A. Rohwer, of the Bureau of Entomology, has recently designed and had constructed a small cage to be used to confine, under natural conditions, growing plants. This cage is a bronze wire cylinder, the top of which is closed by a lid which fits on like the lid of an ash can; the lower end is open and fits against the soil. The frame is made of galvanized iron. The top and bottom are bands two inches wide, with the edges turned, and are held apart by three strips of one inch by one-eighth inch galvanized iron which project six inches below the bottom of the cage so they can be driven into the ground to hold the cage in place. The uprights are soldered to the bands on the inside. The bronze wire is held in place by solder. The lid is a galvanized iron band over the top of which is bronze wire. The cage is eighteen high by fourteen inches in diameter. On one side is soldered a one and one-half inch screw top which affords an easy way of introducing insects after the cage is in place. This cage is very useful in experiments on insects working on living plants, as it is possible to grow, under nearly natural conditions, clean host plants and to infest them with known insects. At the Eastern Field Station it is known as the G type cage and is used in studies on insects of the genus *Evetria* and its parasites. More information concerning its construction or cost may be had through correspondence.

Annual Meeting of Pacific Slope Branch of American Association of Economic Entomologists

The annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists will be held in connection with the meetings of the Pacific Slope Division of The American Association for the Advancement of Science at San Diego, Cal., August 9–11, 1916.

It is hoped that there will be a large gatheringand that all entomologists on the Pacific slope will attend. It is especially desired that entomologists in other parts of the country who anticipate visiting California will arrange their trips so as to be present at this meeting. Further details in regard to the meeting and information concerning the program can be secured by addressing the secretary, Professor E. O. Essig, University of California, Berkeley, Cal.

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LACHNOSTERNA LARVÆ AS A POSSIBLE FOOD SUPPLY

By L. O. Howard

This seems a favorable time to consider the question of new and cheap food supplies. With increasing prices of the old staple foods practically all over the world, with many nations facing very serious shortages on account of war conditions, it would seem that practical suggestions concerning any new cheap food should be especially welcome.

Doubtless many foods now considered excellent were first discovered by starving people. Possibly oysters, clams, snails, crabs, lobster, crawfish and shrimp were first eaten by people who could get no other food. Many things are eaten by semi-civilized people, and even by such nations as the Chinese and Japanese, which Europeans, and especially the Anglo-Saxons, would not think of touching under ordinary circumstances.

Many different insects are eaten in barbarous and semi-civilized countries, and it is certain that the Romans at the height of the luxury of the Empire ate certain insect larvæ as delicacies. There is in fact a rather extensive literature concerning the edibility of insects, based, however, in the main upon historical facts and upon their use among wild people, and containing few or no accounts of practical experiments under modern conditions.[1]

These facts point out the desirability of just such experiments, and practically all our colleges of agriculture, with their departments of home economics and of entomology, are in excellent position to do just this work. First, the edibility of the principal species abundant enough to furnish a good supply must be tested, and when the edibility

[1]Miss Colcord, the Librarian of the Bureau of Entomology of the United States Department of Agriculture, is preparing a complete bibliography of this subject for publication in the near future.

of any one or more of them has been established, careful scientific work on their relative food value must be carried out.

Two kinds of insects from the viewpoint of abundance and possible food value at once suggest themselves, namely, grasshoppers and the larvæ of Lachnosterna in this country and of Melolontha in Europe—the so-called "white grubs."

Grasshoppers have been eaten by so many different peoples that their value as food may readily be accepted, but with white grubs it is reasonable to suppose that the civilized world will have to be convinced. They abound in all grain-growing regions of the United States, and a boy following the plough, if their edibility is once established, would be able to pick up a day's rations for the family in a short time.

With all this in view I have been carrying on a few experiments which I think should be placed on record.

Recently Mr. J. J. Davis, with the help of Professor J. G. Sanders, collected the larvæ of Lachnosterna near Madison, Wisconsin, and Mr. Davis prepared them by clipping off the extreme anal end, at the same time holding them under a running stream of water and pressing the body gently to remove the grit and intestinal parts, leaving them pure white pieces of flesh. They were then placed in a pint jar of salty water (one and one-half teaspoons of salt to a pint of water), and then sterilized under an autoclave at twenty pounds for thirty minutes. They were then sent to Washington in a glass jar. On arrival in Washington they were turned over to Dr. C. F. Langworthy, Chief of the Office of Home Economics of the States Relations Service, of the U. S. Department of Agriculture, who, after straining the grubs through a salt solution, washed them in cold water. He then removed the heads from half of them that one might judge whether one form was to be preferred, or whether both were alike good. They were treated generously with a French dressing made of salt, oil and vinegar, seasoned with white pepper, paprika and salt. Judging that an acid flavor would make the salad more palatable, the proportion of vinegar to oil was rather larger than the usual ratio of one to four or five.

He then made a broth by cooking the liquor strained from the grubs (approximately one-half pint, diluted with one gill of water) with one half onion and seasoned with a tablespoonful of butter and a few shreds of lettuce (a heaping teaspoonful).

The salad was eaten by Messrs. C. H. Popenoe, W. B. Wood, F. H. Chittenden, E. B. O'Leary, R. C. Althouse, W. R. Walton, C. E. Wolfe, and Herbert S. Barber of the Bureau of Entomology and Vernon Bailey of the Bureau of Biological Survey, as well as the writer. It was found very palatable, although in chewing, all of us discarded

the tough chitinous skin. Dr. Chittenden discovered a disagreeable taste which none of the rest of us noticed. He tried only one, and possibly that one may have been a little spoiled. The broth was drunk by Mr. O'Leary and the writer, and we both agreed that it was not only perfectly unobjectionable but really appetizing.

This experiment was made May 17.

A week later Mr. Davis sent in from Lafayette, Indiana, a bottle containing more than 100 grubs preserved in rendered butter, that is, the butter was heated until the water was gone and the casein of the milk had settled and was then strained. The grubs were dressed as previously and were then brought to the boiling point in the rendered butter and bottled. With his colleagues, Messrs. Fenton and Mason, Mr. Davis made a stew which he called delicious, as follows: the dressed grubs were heated in a small amount of water, after which milk was added and the broth seasoned with a small piece of butter, salt and pepper. They prepared the grubs as they thought oyster stew was prepared, and of course ate the grubs as well as the broth. Mr. Mason thought that it tasted very much like boiled crab meat and not much different from lobster. Mr. Fenton thought that it tasted much like lobster, but had not eaten crab and so was not in a position to judge whether they were more like the latter. Mr. Davis had never eaten either fresh crab or lobster, but thought that they had a decided seafood taste. All thought it "agreeable" and "were sorry when it was all gone."

The bottled grubs were sent to Washington, and in Dr. Langworthy's laboratory were made into a soup as follows: A quart of milk, a pint of water, three tablespoons of flour and salt and pepper for seasoning. One tablespoon of the fat in which the grubs had been preserved was browned with one tablespoon of flour. The grubs and the rest of the fat were put into the water and added to the heated milk along with the flour and seasonings.

This white grub stew was very appetizing. It was eaten by Messrs. E. B. O'Leary, C. E. Wolfe, C. H. Popenoe, Joseph Jacobs, A. B. Duckett, C. H. T. Townsend, C. S. Menagh, W. R. Walton, W. B. Wood, and the writer.

Most of us noticed no especially distinctive flavor. Dr. Townsend and the writer, who probably ate more of the grubs than the others, thought that we discovered a slightly acid flavor which is difficult to describe.

Analysis of the grubs will be made in the Office of Home Economics in the Department in order to ascertain their exact constituents from a food point of view, and it is hoped also to make digestion experiments to determine the proportion of the material that can be digested and

assimilated by the body. I feel sure that white grubs will be shown to have a positive food value, and am equally sure that the prejudice against insects as food is perfectly unreasonable.

Should any one following this experience be influenced to make any personal experiments the probable necessity for thorough sterilization of the grubs before use should be pointed out on account of the effects of possible pollution of the soil from which they came.

REDUCING THE COST OF COMMERCIAL SPRAYING

By R. S. Woglum, *U. S. Bureau of Entomology*

The question most frequently asked by the practical horticulturist regarding a spray for the control of insect pests or plant diseases is the cost of application. This cost is an important factor in balancing the profit and loss account, namely the possible increased crop value less cost of treatment compared with the loss from the pest if no treatment is given. The present article discusses briefly certain features of equipment which the writer has been using for more than a year with marked reduction in the cost of certain sprays.

One of the experimental plats used in an investigation of the control of mealybugs of citrus trees in southern California consisted of ten acres, and contained 1,125 trees. It was decided to use this plat in an experiment to control the mealybug by a water spray, the object being to wash the insects from the trees by water under high pressure. Experience having demonstrated that upwards of 100 gallons of water is frequently required for a single tree, it was apparent that very few trees could be properly sprayed in a single day with a power outfit, and, since three to five sprayings a year are necessary for effective work, it was evident that such water control would be very expensive. Furthermore, the contingency of one application closely following another brought up the question of impracticability, if not impossibility, of properly treating an orchard of this size with the one outfit at our disposal.

A very progressive grower near Pasadena had just installed a pipe system in his orchard through which to force water in mealybug control, and this method of distribution appeared of such practical value in treating large orchards that a pipe system was planned and immediately installed in our experimental plat. A plan of this system is shown in the accompanying figure. Some 2040 feet of $\frac{3}{4}$-inch pipe were laid at a depth of about one foot, with uprights for attaching faucets every fourth tree. A power sprayer having a 200-gallon tank was stationed at one side of the orchard adjacent a water main from

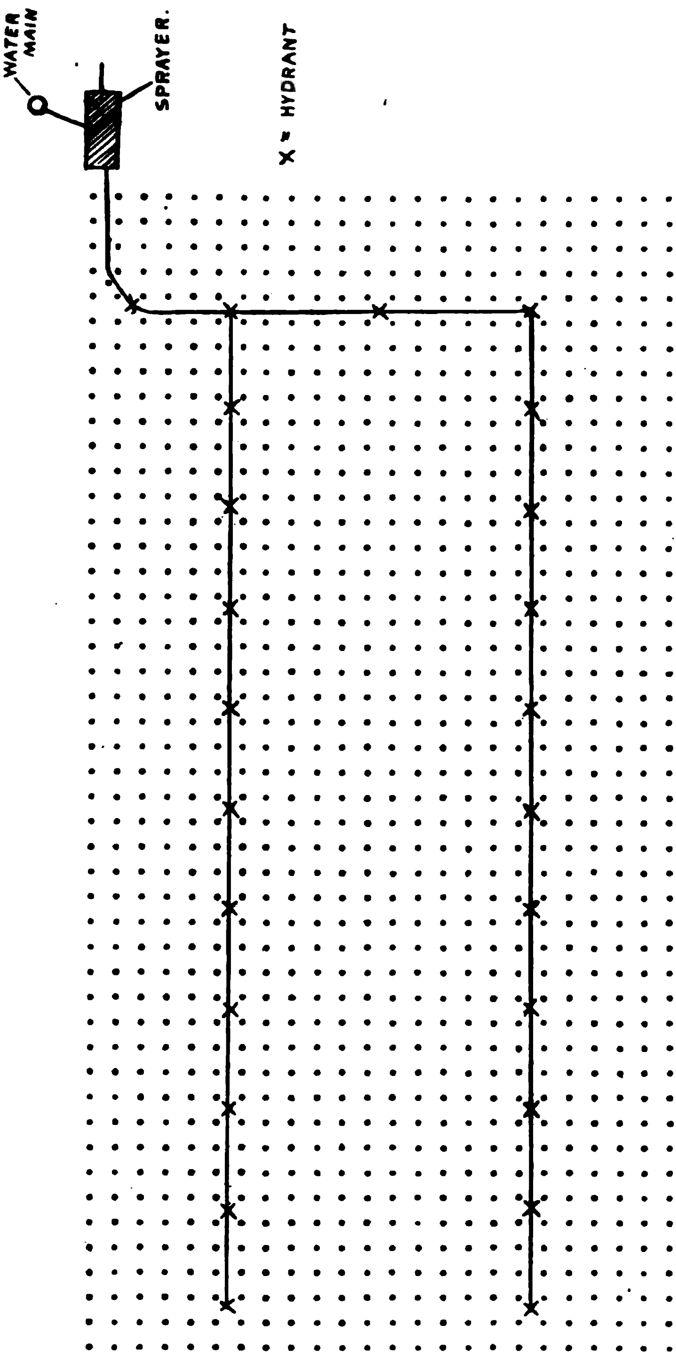


Fig. 22. Diagram of a pipe system in a 10-acre orange orchard by the use of which the cost of spray application was reduced about 75 per cent.

which the water was carried to the tank by an inch pipe and pumped directly into the underground system. Water was thus continuously available at any of the 24 hydrants, and these were so placed that with 150 feet of hose any tree in the orchard could be sprayed. Under this system there is no loss of time for refilling, and the cost of horses is eliminated.

The elements of cost in operating a portable power outfit are engine fuel, labor, and team. This does not include the wear and tear on the machine, wh' 'ld be about equivalent whether stationary or in motion. Estin.. on the basis of an 8-hour day, the actual cost of operation of a power sprayer, as experienced by the writer in southern California, is as follows: fuel averages, 40 cents (gasoline at 15 cents a gallon), labor, $4.00 (2 men at $2.00), team, $5.00; total, $9.40. Under the pipe system the elimination of a team reduces the daily cost of operation by $5.00, or over 50 per cent. Moreover, the avoidance of loss of time for refilling which is necessary with a portable outfit doubtless would amount to at least two hours a day, and results in an additional saving of more than $2.00 a day. The total cost of the application under a pipe system would probably average about 75 per cent less than with a portable sprayer in orchards adapted to this method. The total cost of the ¾-inch pipe system in our experimental orchard was $105.50, or 9½ cents per tree. The economy effected during the first treatment more than paid for this cost.

This system of piping was installed for the use of a pure water spray, but it became apparent to the writer that such a system offered great possibilities in the field of fungicide and insecticide spraying. A part of this orchard was successfully treated with distillate emulsion and with soap powder through the pipe system. Doubtless such sprays as lime-sulphur, nicotine and soap which do not require constant agitation before application could be readily used through long leads of pipe. Where a large acreage of plants requires treatment with such sprays, the installation of a suitable pipe system is likely to prove economical wherever the topography of the ground permits. Furthermore, this system covers fields of insecticide application which have in the past offered almost insuperable obstacles, namely, the treatment of truck crops on mucky land, or orchards on steep hillsides.

A system of piping adapted to each case should be worked out before attempted installation, and certain pertinent suggestions gained during our experimental work might be worth mentioning. The capacity of the pump of the average power sprayer (about 10 gallons a minute) is not adequate for a large pipe system though it would suffice for a few acres where not more than two or possibly four mist nozzles are to be used. To determine the capacity of the pump which should be

purchased, knowledge of the nozzle discharge at the required pressure as well as the loss by friction in the pipe are necessary. Nozzle discharge is easily determined with a spray pump and pressure gauge. The following table of loss by friction of water in pipes shows the loss in pounds pressure per square inch for each 100 feet in length due to friction.

Gallons per Minute	Sizes of Pipe—Inside Diameter, and Loss in Pounds Pressure per Square Inch for Each 100 Feet of Pipe				
	¾-inch	1-inch	1¼-inch	[illegible]	2-inch
5	3.3 lbs.	0.84 lb.	0.31 lb.	0.12 lb.	
10	13.0 lbs.	3.16 lbs.	1.05 lbs.	0.47 lb.	0.12 lb.
15	28.7 lbs.	6.98 lbs.	2.38 lbs.	0.97 lb.	
20	50.4 lbs.	12.3 lbs.	4.07 lbs.	1.66 lbs.	0.42 lb.
25	78.0 lbs.	19.0 lbs.	6.40 lbs.	2.62 lbs.	

It is seldom advisable to use less than inch pipe as the loss by friction in smaller sizes is too great. The main might well be constructed of 1¼-inch pipe. A large mixing tank automatically emptying into the spray tank is necessary to insure a continuous supply of insecticide or fungicide. Drainage outlets at the lowest levels should be provided for emptying the system after use. Where several fields of one or two acres each require spraying a surface system easily and quickly adjustable to be moved from one field to another might offer advantages with certain crops.

ADDITIONAL NOTES ON THE USE OF DUST SPRAYS AGAINST THE CORN-EAR WORM[1]

By JAMES W. McCOLLOCH, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

In the JOURNAL OF ECONOMIC ENTOMOLOGY for April, 1915, the writer presented a paper on "Recent Results in the Use of Dust Sprays for Controlling the Corn-ear Worm." In this paper the following conclusions were drawn:

(1) The amount of corn-ear worm injury can be greatly reduced by the thorough dusting of the silks.

(2) The cost of dusting is prohibitive where corn is raised for grain and forage but is profitable where corn is grown for roasting ears, show purposes, or for seed.

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 19.

(3) Sixty-three per cent arsenate of lead is equally as effective as pure arsenate of lead and costs less.

Experimental work with dust sprays was continued in 1915 for the purpose of confirming the results of 1914 and determining the following points: (1) the number of applications necessary to control the corn-ear worm; (2) the value of different carriers for arsenate of lead, such as lime, flour, and sulphur; and (3) a comparison of 75 per cent arsenate of lead with 50 per cent arsenate of lead.

To determine the first point, eight plots of corn, each one-fifth of an acre in size, were selected. Plot 1 was dusted once, plot 2 twice, and so on to plot 8 which was dusted eight times. The dust used in this experiment consisted of 75 per cent arsenate of lead and 25 per cent sulphur, and was applied to the corn silks by shaking from an ordinary cheesecloth bag. Two check plots were used with this and the following experiments. The average of these two check plots is given in the tables. The results of the first experiment are given in Table I.

Table I[1]

Plot	Treatment	Cost			Per cent Ears Injured	Per cent Grains Injured	Mold and Fungous Injury	Yield
		Material	Labor	Total				
1	Dusted 1 time	$0.25	$0.19	$0.44	65.8	About 5	Bad	13.7 bu.
2	" 2 times	0.36	0.30	0.66	58.8	" 5	"	13.1 "
3	" 3 "	0.43	0.45	0.88	56.8	" 3	Moderate	13.2 "
4	" 4 "	0.71	0.61	1.32	54.7	" 3	"	12.7 "
5	" 5 "	0.95	0.67	1.62	49.6	" 2	Very little	13.0 "
6	" 6 "	0.84	0.82	1.66	47.6	" 1	" "	13.3 "
7	" 7 "	0.84	0.84	1.68	41.0	Less than 1	None	14.0 "
8	" 8 "	0.88	0.90	1.78	26.5	" " 1	"	12.8 "
Check					68.4	About 8	Bad	12.7 "

From the table it will be seen that there is a marked reduction in the percentage of ears injured with each additional dusting. The per cent of ears injured, however, does not represent the true amount of corn-ear worm injury. The number of grains injured and the damage done by the molds and fungi which accompany such injury more nearly represent the actual damage. It will be noticed in the table that these types of injury decrease as the number of dustings are increased. The results of this experiment confirm the results of the previous work in that from 40 to 50 per cent of the normal number of ears injured can be brought through without injury and that the grain and mold injury can be rendered practically negligible.

[1] The data in this and the following tables are based on one-fifth acre plots.

It has been suggested that some carrier, cheaper than sulphur, could be used with the arsenate of lead. In order to gather data on this point, two additional one-fifth acre plots adjoining the previous experiment were dusted, using flour and lime as carriers. Table II gives the results of this test.

TABLE II

Plot	Treatment	Cost			Per cent Ears Injured	Per cent Grains Injured	Mold and Fungous Injury	Yield
		Material	Labor	Total				
8	Dusted 8 times 75% A. of L. 25% sulphur	$0.88	$0.90	$1.78	26.5	Less than 1	None	12.8 bu.
9	Dusted 8 times 75% A. of L. 25% flour	1.04	0.95	1.99	33.1	About 2	Moderate	13.2 "
10	Dusted 8 times 75% A. of L. 25% lime	1.14	0.90	2.04	36.1	" 2	"	12.2 "
Check					68.4	" 8	Bad	12.7 "

From these results it will be seen that with the use of sulphur there was a lower percentage of ears injured and the cost of the treatment was considerably lower. Lime and flour did not seem to adhere to the silks and consequently a larger amount of material was used. There was considerable mold and fungous injury on plots 9 and 10 which would indicate that the sulphur plays an important part in the dust spray as a fungicide.

In order to confirm the statement in the previous paper that the 50 per cent arsenate of lead was not effective enough to warrant its use, a plot was dusted with equal parts of arsenate of lead and sulphur. The results of this experiment are shown in Table III.

TABLE III

Plot	Treatment	Cost			Per cent Ears Injured	Per cent Grains Injured	Mold and Fungous Injury	Yield
		Material	Labor	Total				
8	Dusted 8 times 75% A. of L. 25% sulphur	$0.88	$0.90	$1.78	26.5	Less than 1	None	12 8 bu.
11	Dusted 8 times 50% A. of L. 50% sulphur	0.81	0.94	1.75	40 4	About 2	Very slight	12.7 "
Check					68.4	" 8	Bad	12.7 "

The following conclusions may be drawn from the results obtained in these experiments:

(1) The percentage of corn-ear worm and mold injury decreases as the number of dustings are increased.

(2) The cost of dusting is prohibitive where corn is grown for grain or forage but is practical where corn is raised for roasting ears, show purposes, or for seed corn.

(3) Sulphur is superior to flour or lime as a carrier for arsenate of lead and there is some indication that it also serves as a fungicide.

(4) Fifty per cent arsenate of lead does not control the corn-ear worm as effectively as does 75 per cent arsenate of lead.

A NEW SPECIES OF ISOSOMA ATTACKING WHEAT IN UTAH[1]

By R. W. Doane, *Stanford University*

During the past two summers, while carrying on certain investigations in Utah, for the American Smelting and Refining Co., Department of Agricultural Investigations, I have had an opportunity to study the life-history and habits of different wheat-infesting *Isosoma*, and to note something of the effect of their work in the wheat fields.

In the so-called dry farm regions in Salt Lake Valley it is a common custom to plant wheat every other year, letting the fields lie fallow during the alternate years. Often, however, the fields are not plowed during the year that they are supposed to lie fallow, but are allowed to grow a volunteer crop which is sometimes more or less profitable. The plowing that is done at any time is usually with a disc plow and a large part of the straw and stubble is left on the surface of the ground.

It will at once be seen that such farm practices offer almost ideal conditions for the development of stem-infesting wheat pests, and it is not surprising to find the Isosomas doing an immense amount of injury there, sometimes reducing the crop yield to a small proportion of what it normally would be.

My attention was first called to these pests when I found the adults in considerable numbers in a field of winter wheat in May, 1914. Two species were collected at this time. One proved to be the well known wheat straw worm, *Isosoma grande*, the other species, as far as I can determine, is undescribed. Because the larvæ confine their attacks to the leaf-sheath, I have called the species *Isosoma vaginicolum*,

[1]Contribution from the Laboratories of the American Smelting and Refining Co., Department of Agricultural Investigations.

Fig. 1 Young wheat in which nearly all of the stems in the stool have been affected by *Isosoma vaginicolum*.

Fig. 2. Wheat straws that have become distorted on account of the work of *Isosoma vaginicolum*.

and have used the common name of "the wheat sheath worm." A brief description follows:

Isosoma vaginicolum n. sp.

Head, wholly opaque black, finely punctate, with fine white pile; antennæ black, basal segments faintly yellowish, especially below, the club somewhat shorter than the three preceding segments taken together, thorax black, finely punctate, in certain lights a faint yellowish spot may be seen on the anterior lateral corner of the prothorax; coxæ and trochanters black; femoræ of the first pair of legs black at base, yellowish toward the tip, in some instances nearly all of the distal half, especially below, is yellowish; femoræ of other legs black, yellowish at tip; anterior tibiæ yellowish, sometimes somewhat darker, especially below; other tibiæ blackish, yellowish at base and tip; tarsi yellow, last segment darker at tip; wings reaching to the tip of the abdomen; abdomen shining black, extreme tip (ovipositor sheath) yellowish; length 3 mm.; wing expanse 5½ mm. to 6 mm.

Isosoma grande, which is found in the same fields as *I. vaginicolum*, may easily be distinguished from the latter species by its large size and shining thorax. A few specimens of *I. tritici* were also found in this region. They may be distinguished from *I. vaginicolum* by the basal segment of the antennæ being wholly black and the club being

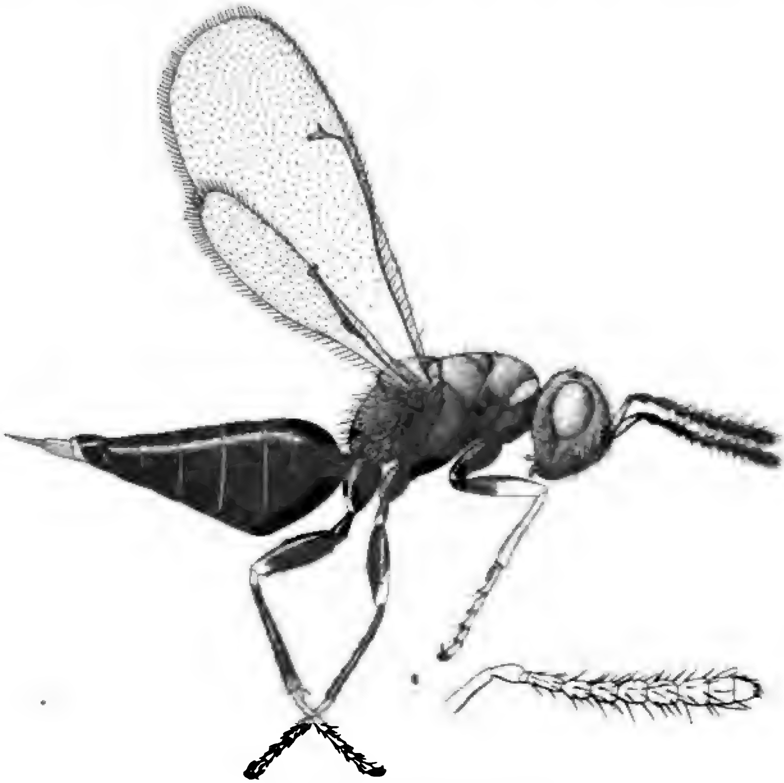


Fig. 23. *Isosoma vaginicolum.*

as long or longer than the three preceding segments taken together. The face of *I. tritici* is somewhat longer and the abdomen broader posteriorly, that is it is not quite as tapering as in *I. vaginicolum*.

Most of the adults of *I. vaginicolum* appear during the month of May. At this time they may be found laying their eggs in the base of the leaf-sheath just above one of the joints, usually near the middle of the stem. Three or four or often as many as fifteen or twenty eggs may be laid close together and when the larvæ begin to develop the leaf-sheath becomes more or less swollen. Each larva is enclosed in a firm little oval cell from a quarter of an inch to three eighths of an inch long. The swelling and hardening of the walls of the sheath presses on the stem in such a way as to prevent the sap from flowing through it readily and the plants become stunted and produce only small, poorly-developed heads. If the plants are badly affected or if they are infested early, they may produce no heads at all or the heads may never develop far enough to burst from the protecting leaf-sheath. In some fields eighty to ninety per cent of the wheat stems are infested and the crop loss will amount to from fifty to seventy-five per cent. I have seen some fields so badly injured that they were not considered worth the harvesting and the whole crop was a total loss. If the larval cells are very close to a joint they often cause conspicuous knots and the stem becomes much distorted. These swollen and distorted stems resemble very much the stems that have been injured by *I. tritici*, but a careful examination will show that the cells occur only in the leaf-sheath, whereas the larvæ of *I. tritici* are found in the walls of the stem of the plant.

The larvæ remain in the stems throughout the summer, fall and winter, and pupate in their cells during April and May. Most of the adults issue in May and early June.

I have found *Isosoma vaginicolum* only in the dry farm region. *I. grande*, which occurs with it there, has a much wider distribution, being found commonly in the wheat fields in the irrigated districts as well. In the well-tilled, well- irrigated fields, however, the injury that the wheat straw worm does is not as important or noticeable as it is in the dry farm regions, where the loss of the young plants due to the work of the first generation of larvæ, and the hardened thickened walls of the stems, due to the presence of the summer brood of larvæ, affects very seriously the quantity and quality of the yield of wheat. The effect of the work of this insect in the wheat fields in this state is similar to the conditions described by Webster and Reeves in Circular 106 of Bureau of Entomology.

I have found, both in Utah and California, that if a very young plant is attacked by the larvæ of the second generation it may be

destroyed or made to stool excessively, the effect being the same as produced by the work of the first generation of larvæ in the earlier wheat.

A little later, but still early, infestation with *I. grande* affects the height and size of the stem and the size of the head, usually making the head small or very small. An early infestation of the highest or next to highest joint affects the size of the head but does not appreciably affect the height of the stem. Infestation of the third joint does not seem to affect the plant as seriously as infestations higher or lower made at approximately the same time. A very late infestation may occur in one or even in two or three joints without seriously affecting the stem or the head.

NOTES ON RHOGAS TERMINALIS CRESS.

(*Hymenoptera, Braconidæ*)

By W. E. Pennington, *Scientific Assistant, Cereal and Forage Insect Investigations*[1]

During the summer and fall of 1914 a very severe outbreak of *Cirphis (Heliophila) unipuncta* Haw. occurred at Hagerstown, Md. This outbreak was carefully investigated by the force of the United States Entomological Laboratory located at that point. Incidental to this work several parasites of the insect were reared. This paper deals with the data collected on one of these parasites, *Rhogas terminalis* Cress. (Fig. 24*a*), and is presented at this time because it throws a little additional light on the phenomenon of parthenogenesis.

During late September, October and early November, a large number of *Cirphis unipuncta* larvæ were collected from the field. These larvæ were isolated in tin salve boxes two inches in diameter and three quarters of an inch deep. As the larvæ were isolated, they were arranged by accession numbers which were marked with wax pencil on the top of the box. The cages were stored in galvanized iron trays (Pl. 30), were examined daily and fresh food supplied when necessary. In this way the data was exact from the time of collection of the original host to the completion of the experiment. From this material the initial series of *Rhogas terminalis* for the following experiments was obtained.

Table I gives the exact data relative to the emergence of the stock material.

The first note made at this Laboratory on *Rhogas terminalis* is dated August 7, 1914, on which date J. A. Hyslop collected nine adult fe-

[1]My thanks are due Mr. J. A. Hyslop for helpful suggestions and assistance in preparing the test and furnishing the illustrations; for the original adults making the experiments possible, and for the courtesies of full coöperation.

males and one male at the Laboratory trap light. Adults were collected throughout August, September and October by other members of the staff at the same light.

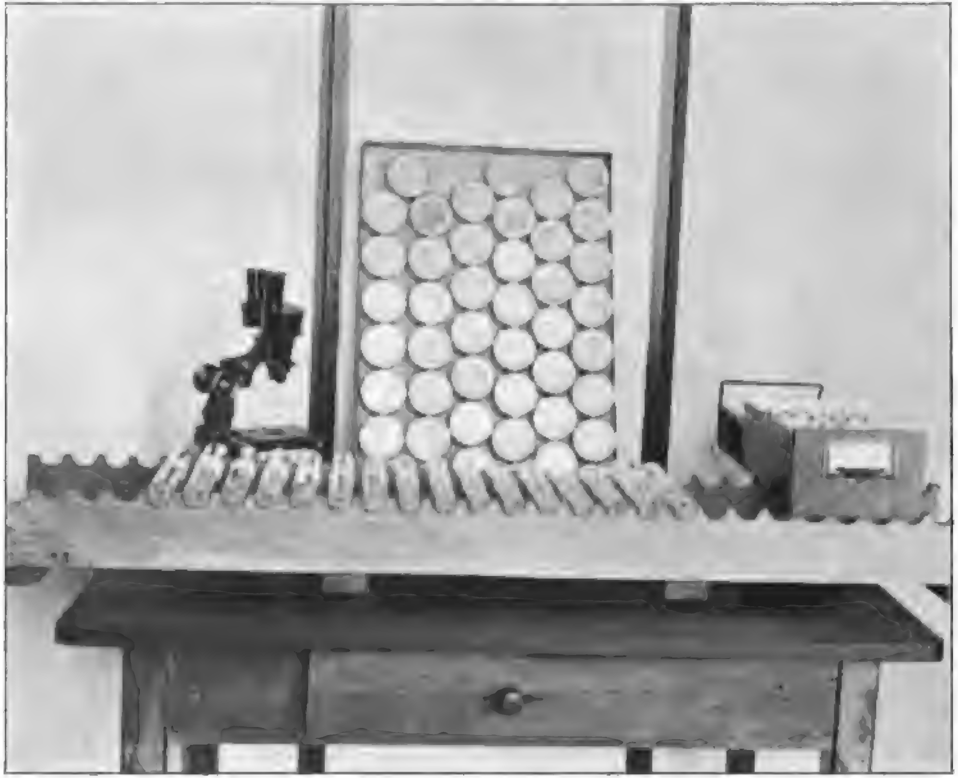
In 1915 the adults first appeared in mid-April. On March 30, H. L. Parker collected a puparium in the field, from which an adult emerged in the Laboratory April 9. On April 17 he collected a puparium from which the adult had but recently emerged, and on the 27th an adult was taken at the trap light and a pair swept in an alfalfa field. Adults were taken throughout May, June, July and August of 1915, so, with the 1914 data, it is evident that they are present in the field from mid-April to early November.

TABLE No. I

No.	Date of Collection of Larva	Date Parasite Formed Puparium	Date of Emergence of Adult Parasite	Date of Death of Adult Parasite	Sex of Parasite	Duration of Puparium Stage in Days	Length of Life of Adult in Days
	1914	1914	1914				
1	Sept. 22	Sept. 26	Oct. 13	Oct. 13, 1914	Female	17	1
2	Sept. 22	Oct. 2	Oct. 19	Nov. 30, 1914	Female	17	43
3	Sept. 22	Oct. 6	Oct. 23	Jan. 6, 1915	Female	17	75
4	Oct. 2	Oct. 6	Oct. 24	Nov. 30, 1914	Female	18	37
5	Sept. 23	Oct. 8	Oct. 31	Nov. 27, 1914	Female	23	27
6	Sept. 26	Oct. 13	Nov. 11	Jan. 19, 1915	Female	29	69
7	Oct. 2	Oct. 13	Nov. 7	Nov. 7, 1914	Female	25	1
8	Oct. 2	Oct. 19	Nov. 19	Jan. 5, 1915	Female	31	47
9	Oct. 2	Oct. 19	Nov. 17	?	?*	29	
10	Oct. 2	Oct. 19	Nov. 19	Jan. 27, 1915	Female	31	69
11	Oct. 20	Oct. 23	Nov. 19	Jan. 27, 1915	Female	27	69
12		Oct. 26	Nov. 20	Jan. 4, 1915	Female	25	45
13	Nov. 10	Nov. 16	Nov. 27	Dec. 8, 1914	Male	25	45

* Escaped.

Numbers 1 to 7 were kept under practically normal field conditions, as to temperature, in a cold cellar. Numbers 8 to 13 inclusive were kept in the same cellar until the middle of November when they were removed to a heated room for the experiments which followed. All host larvæ used in these experiments, after obtaining the original parasite from a larva collected in the field, were reared from eggs laid in the Laboratory by moths which were themselves reared and mated in confinement. The host larvæ on hatching were isolated in the salve box cages and given accession numbers. It was found advantageous to place a piece of moist blotting paper in each box for the first two instars as dessication rapidly destroyed the very young larvae. By this method of procedure the exact age of every host larva exposed to a parasite was known and the possiblity of previous infestation by parasites precluded.



Apparatus used in *Rhogas terminalis* experiments: *a*. Galvanized iron tray holding 40 salve boxes; *b*. rack holding Doten cages; *c*. filing system unit for notes; *d*. binocular microscope.

The adult parasites were transferred to separate cages adapted from the cage described by Doten[1] (Pl. 30). A small piece of sponge soaked with honey water was put in daily. This liquid seemed a satisfactory food, so no other was tried.

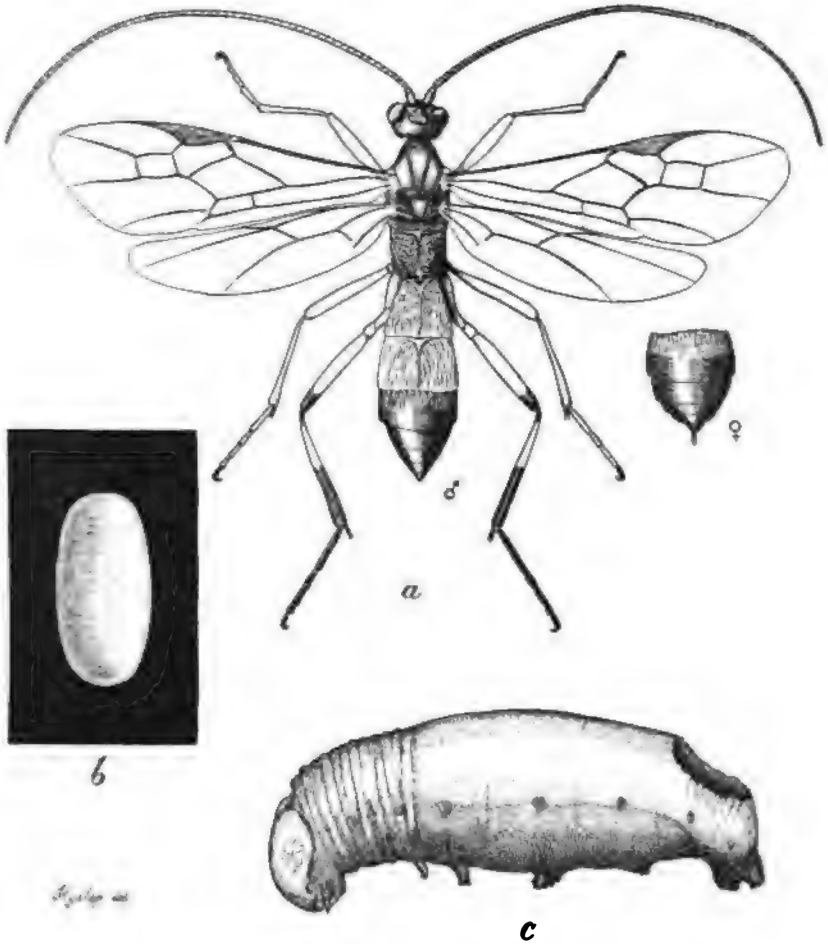


Fig. 24. *Rhogas terminalis* Cress.: *a*. adult; *b*. egg; *c*. puparium.

Into each of these cages the *Cirphis* larvæ were placed, one at a time. All relations between the parasite and its host were then carefully observed and recorded, the larva removed to its own cage, and the appearance and emergence of the subsequent parasite noted.

This parasite copulates immediately on emerging. The male, when the presence of a female is perceived, shows evident excitement by

[1]Doten, S. B., University of Nevada, Tech. Bul. 78, Sept., 1911.

vibrating the wings and antennæ. He very deliberately approaches the female and immediately copulates, the operation taking but about one minute. During copulation the male rapidly moves the head, tapping the raised antennæ of the female with his own, she remaining still in every member.

Oviposition rapidly follows copulation and is extremely rigorous. The female on locating a host larva raises with the fore legs the anterior part of her body, thrusts forward the abdomen between the legs and advances to striking distance. The strike is very rapid, the parasite rushing upon its host and inserting the ovipositor within a fraction of a second. The host resists. It bites, exudes a dark fluid from the mouth and squirms violently. Often the parasite will withdraw from its struggling host, but in a couple of seconds resumes its attack. It is possible that a deadening sting is inflicted with the first strike, and then oviposition is effected.

The egg (Fig. 24*b*) is elongate oval with the sides nearly parallel, the surface is finely rugose, and the color is glistening white semi-translucent. The egg measures .18 mm. in length and .09 mm. in diameter.

The puparium (Fig. 24*c*), as is the case with many species in this genus, is made of the transformed and reinforced larval skin of the host. The shape is fusiform with the ventral surface flattened and affixed to the object on which it rests by a black viscid exudation, the surface is turgid almost obliterating the segmentation of the host larval skin, the color is deep rufous brown to black. The length averages 9 mm. and diameter, 3 mm. The adult parasite emerges by gnawing an irregular hole caudad in the dorsum of the host skin.

For convenience in referring to the original mother-parasites, the females with which we began the experiments will be called "Rhogas 2," etc., and on up to "Rhogas 13" (Table I). All foregoing data relative to these parent females is to be had from this table.

To "Rhogas 2," larvæ were exposed on November 15 and 23 respectively. Puparia of offspring parasites appeared from these larvæ November 30 and December 14 respectively, giving 15 days for the egg and larval period (up to formation of puparium) of the parasite in the first case and 21 days in the latter case. Adults emerged December 24 and 29 respectively. Both were males. No male was brought near this female, and therefore these offspring were produced parthenogenetically.

"Rhogas 3," being unmated, was placed in a Doten cage and a host larva put in on November 17. It was immediately stung by parasite and then removed. A parasite appeared from this host larva on December 9, the adult male emerging on December 26. Likewise,

this female oviposited in a host larva on December 10, the puparium being formed on December 31, the adult male emerging on January 14, 1915. On December 4, after a male had been placed with this female, but no copulation observed, although the pair was carefully watched, the female oviposited in a larva. The larva was removed to its private cage and the offspring appeared and formed puparium on December 24. The adult emerged on January 9 and was a female.

From "Rhogas 4" were reared five males parthenogenetically.

From "Rhogas 5" were reared five males parthenogenetically.

From "Rhogas 6" were reared four males and one female. Two of these males were reared from eggs deposited in larvæ before placing "Rhogas 6" with a male. After introducing a male into the cage, and noting copulation, this female deposited eggs which resulted in the production of one female and two males.

From "Rhogas 8," unmated, was reared one male parthenogenetically.

From "Rhogas 10," unmated, was reared one male parthenogenetically.

From "Rhogas 11," unmated, were reared two males parthenogenetically.

From "Rhogas 12," unmated, were reared two males parthenogenetically.

A total of 27 successful ovipositions occurred under artificial conditions.

The earlier stages of these for both males and females are similar in duration. The egg and larval period, up to time of formation of the puparium, for both sexes averages 19.1 days. The puparium stage averages 16.7 days, while the length of life of the adult parasites, under artificial conditions, varied remarkably between the two sexes. Males lived on an average 16.5 days, while the females averaged 32.5 days, the longest lived female surviving 75 days; the longest lived male, 35 days.

Temperature played an important part in the development and emergence of adults after the puparium had been formed. A cool period of a few days continuation would apparently interfere with the normal activities and the adult would be delayed in emerging.

It is interesting to note the sex of the offspring of parthenogenetic females as compared to that of offspring of normally mated females. Only males were produced from eggs deposited parthenogenetically. The one apparent exception in the case of "Rhogas 3" being doubtful as to whether or not copulation took place between the female parent and the male to which she was exposed. From mated females, offspring of both sexes were produced. The rule that females alone are

produced from fertilized eggs is still tenable, despite the apparent contradiction in case of number 6, for it is possible that all eggs laid by a pregnant female are not supplied with spermatozoa.

The female Rhogas oviposits, under laboratory conditions, in larvæ of the second and third instar; the parasite puparium is formed when the host larva has reached the fourth or fifth instar.

Conclusions to be drawn from this experiment are as follows:

1. There are probably four complete generations of *Rhogas terminalis* in this region, with a maximum possibility of six generations per year.
2. The parasite hibernates in the puparium stage.
3. The females are nearly twice as long-lived as the males.
4. The parasite is present throughout the entire active season of its host.
5. The parasite oviposits only in second and third instar host larvæ.
6. Eggs are laid within the host.
7. Parthenogenetically, males only are produced.
8. Mated females produce both males and females, the latter, however, are decidedly predominant.

INVESTIGATION AND INSTRUCTION IN BEEKEEPING[1]

By Morley Pettit, *Provincial Apiarist, Guelph, Ontario*

It is the first duty of an investigator and instructor in Apiculture to establish his reason for existence. This was done in the writer's first annual report as Lecturer in Apiculture at the Ontario Agricultural College, published in the annual report of that College for 1909, as follows:

"Beekeeping is one of the most pleasant, healthful, and profitable of rural occupations. . . .

"A large percentage of beekeepers fail from lack of good management. This can be overcome only by education and training. Many a one owes success to early training received in the apiary of an experienced apiarist. Add to this training a scientific college course in the underlying principles of apiculture and you have greatly increased possibilities for success.

"To obtain an intelligent idea of the subject the underlying principles of bee nature must be mastered. Bees are not domesticated in the same sense as farm animals. They are simply wild insects induced to

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[1] This and the following three papers were read at a meeting of Instructors and Investigators in Apiculture held at the last annual meeting of the American Association of Economic Entomologists.

dwell near our homes by being provided with conditions most suited to their comfort and prosperity. It has been the purpose of the lecture course to describe these conditions, to give an outline of facts with which every beekeeper must be acquainted."

It is the purpose of beekeeping investigation to determine the principles of bee nature and of instruction to convey them along with methods of their application to the student. From 1909 to the present, it has been the writer's purpose, as yet realized to a very limited extent, to make it "possible to look to the graduating classes of the Ontario Agricultural College, for valuable assistants and foremen of apiaries, trained inspectors of apiaries, queen breeders, lecturers, experimentalists and experts in all lines of beekeeping."

1. Investigations in Apiculture

The problems of investigation proposed in that first report were the following:

Wintering bees; the prevention of swarming; preparation of honey for sale and the marketing of it; the production of commercial beeswax; the control of the mating of queens; the influence of weather conditions on the working of bees and the nectar secretion of flowers; the comb building of bees, including the use they make of comb foundation; the separation of the wax and honey contained in cappings without injury to the honey; the testing of appliances offered for sale by dealers; the testing of queens sold by commercial queen breeders; problems connected with bee diseases.

Most of these problems are as yet almost untouched, owing partly to a lack of equipment, and mostly to the pressure of executive work and teaching. By attention to the well known essentials we are able to winter bees and prevent swarming with more than average success. Successful methods of packing and marketing honey have been investigated and reported on from time to time. Various methods of rendering beeswax from old combs and refuse have been tested. An experiment conducted by C. P. Gillette of Colorado, some years ago, to determine the amount of wax from foundation used in the cell walls in comb building was repeated with similar results to those obtained in Colorado. Various capping melters on the market have been tested to discover some practical method of removing all the honey from the wax without injury to the honey from overheating or contact with the melted wax. During the season of 1915, a honey crop of about 20,000 pounds of honey was extracted in a commercial apiary using the Peterson Capping Melter with good success. This device has a flat surface heated by hot water and slanted to run off the mixture as soon as the wax is partly liquefied. A gravity separator removes the honey quickly from the wax. Queens sold by a number of queen breeders have been

tested coöperatively by different beekeepers in Ontario under the writer's direction. These tests have been made with particular reference to resistance to European Foulbrood. The results have been published by the Ontario Department of Agriculture in a bulletin entitled "Some Results of Coöperative Experiments on Races of Bees to Determine Their Power to Resist European Foulbrood."

"The conclusion reached by the writer with reference to races and strains of bees is that resistance is more a matter of vigor than of race or strain. Results of tests show, however, that common black bees are exceedingly poor resisters, and that Carniolans are not generally as good as Italians. . . . Evidence in favor of leather-colored Italians is perhaps stronger than that for the yellower strains. . . .

"So far as it can be seen by the careful observer who is not a bacteriologist, the disease diminishes in virulence after it has been in a particular locality for a few years. It is also true that the resistance of the bees increases as a result of natural selection or 'survival of the fittest.' On the other hand, apiaries previously Italianized and carefully watched when the disease arrives are not so badly affected."

2. College Instruction in Apiculture

(a) With Long Course Students.

This consists of twenty-five lectures and a few laboratory periods compulsory with all first-year students. The work is based on a text-book,—"Langstroth on the Honey Bee," revised by Dadant. While not entirely fulfilling the writer's ideas of a college text-book, this has perhaps been the best on the market. A change will likely be made to "Beekeeping" by Phillips.

Very little attention is given to the biology of the bee. The teaching of evolution, morphology and physiology, while important, is left largely to the biologist. A brief survey of external anatomy and of the systems of nutrition, respiration and reproduction is sufficient to call attention to the organs and processes of interest to the beekeeper. Enough development is given to explain the life-history of each of the casts. Pathology and hygiene of the apiary are also important.

Our main business, however, is to teach bee psychology, including behavior. On a knowledge, conscious or subconscious, of this, all successful bee management rests. It has usually been acquired by years of experience punctuated by heavy losses. To collect, classify, increase and transmit this knowledge is the task which confronts us. It is not a light one.

It is much easier to describe, for instance, a method of introducing queens than the principles of bee psychology on which all queen introduction must be based. But the student who is not taught these

principles must learn them by the successes and failures of many experiments.

The extent to which the teacher may abstract principles from methods will depend on his own knowledge and on the previous mental training of his class.

It is a very important part of our work to secure a status for the subject in agricultural colleges, and it is gratifying that the deadly indifference if not open ridicule to which it has been subjected in times past is being overcome, although there is room for a great deal of improvement yet.

We consider it a great advantage at the O. A. C. that the subject is compulsory with all first-year students. It gives every student an opportunity to learn something about it. Those who become interested are as far as possible given work in the Apiculture Department, or positions are secured for them with successful beekeepers for the ensuing summer vacation.

In the second year every student of the college has a thesis to write and he may choose a beekeeping subject. Those whose interest continues are given more important work the second vacation, perhaps as inspectors of apiaries. This is continued in the third-year vacation, and they are advised to take the biology option and write their graduation thesis on a beekeeping subject.

So far our efforts to secure a larger place on the curriculum for Apiculture have been without avail, and as there are no elective subjects, except the main divisions called "options" in the graduating year, the difficulty of getting a new subject on the junior years is greater than it is in colleges where electives are common throughout the course.

Two men have already graduated as Apiculture specialists in the Biology Option, and have gone immediately to good positions. The increasing demand for men with this sort of training will doubtless compel our college authorities to give us a proper place at an early date.

(b) With Short Course Students.

The Ontario Agricultural College has no general short courses, but has short courses for different subjects such as dairying, poultry, beekeeping, etc. In the Beekeeping Short Course, we aim to cover practically the same ground as with the long course students; the difference being that the lectures are given consecutively six or seven each day for a period of two weeks, and the services of instructors from other colleges, also successful inspectors of apiaries in Ontario, are secured to lighten the labors of the Provincial Apiarist.

Printed programs are prepared and mailed to a large number of beekeepers and others who will be interested. The attendance varies from fifty to one-hundred, depending largely on the nature of the previous honey season.

(c) The Students' Apiculture Club meets every two weeks during the term, and is addressed on practical topics by successful beekeepers. Occasionally such prominent men as Dr. Phillips, Dr. Gates, Mr. Dadant or Mr. Root are secured, and their lectures add much to the interest of the club.

(d) Extension Work.

Local short courses have not been undertaken, although they would doubtless be valuable. Bee institutes in winter have been found quite successful in some districts. They give better results than bee lectures at general farmers' institutes. Quite a number of lectures on beekeeping are given at local agricultural short courses held by district representatives. Many of the twenty-six county beekeepers' associations request and receive lecturers at our expense. The most popular form of extension work is the summer apiary demonstration. Of these we held 60 in 1915, with a total attendance of 1,910 persons, an average of 32. Most beekeepers like to be shown as well as told. These demonstrations are arranged and advertised from the office of the Provincial Apiarist. Form post-cards and letters are used, also a list of about 8,000 beekeepers arranged geographically, an addressing machine, stamp affixer, envelope sealer, and whatever other office devices are available.

Demonstration apiaries have been recommended, but so far have not been tried in Ontario. These would be particularly valuable in districts where beekeepers have become discouraged through European Foulbrood. They would need to be managed in series by a man with motor cycle or light motor car.

Demonstrations and educational exhibits at fairs and on Better Farming Special Trains have been conducted to a limited extent. They are valuable in calling public attention to beekeeping, also to the use of honey, but for educating beekeepers themselves, they are not worth nearly so much as the apiary demonstrations.

Not much need be said on correspondence and publications. These are conducted along the usual line. During 1915 about 7,000 letters and reports were received and 5,000 sent out. During the year 43,670 circular letters, report forms, and cards advertising demonstrations were sent out to Ontario beekeepers. We are using the mails to help take the Ontario Agricultural College to the beekeepers of Ontario, and the many kind letters received show that most of them appreciate it very much.

The Apiculture Division of the Experimental Union is really a part of our Extension Work. Early in the year circulars are sent to the complete list of beekeepers offering them a list of experiments, including methods of management and appliances to be tested, also a form on which they can make application for any one of the experi-

ments they wish to test. On receipt of the application properly filled out, the material for the experiment requested is sent, also a form on which the results can be reported. These results are collected at the end of the season, tabulated and summarized for a report.

It will be seen that the educational value to the experimenter who tests some successful method of management under our direction, is even greater than the information gathered from his report, although that has a real value as well.

The Opposition of Beekeepers to Apicultural Education

This is met with to a limited extent from older men, the claims being:

(a) That it will make more beekeepers and crowd the pasturage.

(b) That the increased number of amateur beekeepers will increase the disease menace.

(c) That an increased production of honey will lower the price and reduce the profits.

These objections may be answered as follows:

(a) Vast areas of bee pasturage are at present unoccupied. Any crowding which now occurs is due to the example of successful beekeepers. Instructors should carefully warn against over-stocking.

(b)–Educated amateurs will reduce rather than increase the disease menace.

(c) An increased production with proper distribution and advertising would so develop consumption of honey that it would become a staple with advancing prices. Incidentally education would greatly lower the cost of production.

In Conclusion

It is our business to study bees, their biology, psychology, activities and products, and their relation to climate; also honey flora and nectar secretion and their relation to climate and soils. Incidentally we must study system, efficiency and economics.

It is our business to transmit to the best of our ability the results of these investigations, so that we may have the satisfaction of seeing, if not two bees where one grew before, at least an increase in the sum of enjoyment and profit in this most enjoyable of pursuits.

BEE WORK AT THE CANADIAN GOVERNMENT EXPERIMENTAL FARMS

By F. W. L. Sladen, *Apiarist, Central Experimental Farm, Ottawa*

In the Dominion Department of Agriculture bee culture experiments were started in 1891 under the Division of Entomology and Botany of the Experimental Farms Branch, with two colonies at the Experi-

mental Farm at Brandon, Man. In the autumn of 1893 an experimental apiary was instituted at the Central Experimental Farm at Ottawa, and Mr. John Fixter, who was then farm foreman, was placed in charge of it. In the autumn of 1912 Mr. F. W. L. Sladen was appointed Assistant Entomologist for Apiculture in the Division of Entomology and, when on April 1, 1914, this Division became a separate branch of the Department of Agriculture, the bee experimental work became a separate Division of the Experimental Farms Branch.

The work undertaken by the Bee Division is entirely experimental and consists (1) of experimental work at the Central Farm, Ottawa, and (2) experimental work at the Branch Experimental Farms.

Bees are now kept on thirteen of the Dominion Experimental Farms. Usually the man in charge of the poultry looks after the bees. We find that it is necessary for him to examine the colonies on a certain day every week during the swarming season. It has been demonstrated that bees can be kept profitably at all of these Farms, although at Nappan in Nova Scotia the wintering problem has been found somewhat difficult, both on account of unwholesome stores gathered by the bees and the long winter with its sudden changes in temperature. The principal work is now, therefore, investigating the sources of honey, its quantity, quality and period of production, variation from year to year, etc., the object being to give, eventually, reliable information as to the profitableness of beekeeping for beekeepers who dwell or settle in the regions served by the different Farms, which cover almost the whole of the settled parts of Canada. Hives are kept on scales and the daily weights recorded. When substantial increases in weight are noted, investigations are made in the field to discover the source of the nectar. Samples of the honey are taken from the supers from time to time. It is being recognized that much of this work will have to be done in summer out-apiaries situated at some distance from the Farms, and this development was begun this year on several of the Farms. Some interesting results have already been obtained at some of the Experimental Farms, for instance, alfalfa has proved a valuable source of honey in Southern Alberta.

The best kind of winter and spring protection required to produce good results, and the best methods of spring and summer management and of swarm control at each Farm, are also being experimentally investigated.

The Branch Farm apiaries report to the Central Experimental Farm three times a year—in spring, summer and autumn—on forms in which a number of questions are asked. This year simple forms for a weekly report during the active season when swarming is possible have been started. On these forms are asked the condition of each

colony and what steps have been taken to control swarming, and they are mailed to the Central Farm the day after the weekly examination of the colonies is made.

At the Central Farm the principal problems that are being investigated are swarm control, both by breeding and by manipulation, and wintering, both out-of-doors and in the cellar. Summer out-apiaries are also being established in places where different natural conditions are found such as swamps and sandy plains, so as to investigate the sources of honey there and to ascertain its quality and quantity, and the botanical names of the plants yielding it, and also to investigate the conditions under which they yield. A honey plant herbarium and honey museum are being started. About fifty colonies are kept at the Central Farm, and an average annual crop of between 2,000 and 3,000 pounds of honey has been obtained from it in recent years.

An apicultural building 27 feet by 32 feet with underground basement, containing three bee cellars, is now in course of construction at the Central Experimental Farm, and will, it is expected, be ready for occupation in January. Arrangements are being made to have the temperature, humidity and ventilation in the three bee cellars under artificial control.

One of the functions of the apiaries at the Branch Farms is the supply of bees in observation hives to a large number of fairs to which the Dominion Experimental Farms send exhibits. These observation hives contain one Langstroth frame with brood and honey with the adhering bees and three sections or a shallow frame, containing honey, on top, between sheets of glass.

THE PURPOSE OF COLLEGE BEEKEEPING

By E. F. Phillips, *Bureau of Entomology, Washington, D. C.*

The teaching of beekeeping in agricultural colleges is relatively new. While the work has been sporadically included in such courses for many years, no serious attempt was made to give a constructive balanced course until within the last decade. The increase in this work is highly encouraging but that there are problems to be settled is evident from the desirability of this meeting. It may be assumed that the college authorities do not know definitely what sort of course should be given in so specialized a subject, and it is auspicious that the instructors in this subject have realized the desirability of a conference.

Not being engaged in teaching, I shall not presume to give advice as to the details of the course. It may be an advantage to view the problem from the outside and to look at it from the standpoint of the needs

of the beekeeping industry, from which point of view one has a right to suggest.

Little need be said of the malignance of an over-enthusiastic presentation of the possibilities of beekeeping. The booming of the industry is detrimental to those induced to take it up through false representation and it is perhaps even more harmful to the industry and to the institution that permits such a presentation. Beekeeping can readily be painted in too bright colors, even by telling nothing but the truth, but no presentation is honest which does not tell the whole truth. As the demand for beekeeping courses will probably increase more rapidly than the supply of qualified instructors, this is a danger which must possibly soon be faced.

The beekeeping industry needs more of two classes of adherents: (1) the beekeeper who is interested in advancing the scientific phases of bee culture, and (2) the professional honey-producer. There are today more professionals than there are scientific beekeepers but the majority of the professionals are men above middle-age and there are few young men taking up the work. Beekeeping is too strenuous a business to depend on amateurs for its existence for, what with the brood diseases and lean years, the amateur is an unstable factor that does not make for permanence in the industry. It is easier to make professional beekeepers than it is to make scientific beekeepers for two reasons: the training is less exacting and the raw material is more plentiful. The advance of the industry depends chiefly on the work of scientific beekeepers, but its permanence and growth depend on commercial beekeepers. The amateur has little effect on beekeeping except on those who sell the beekeeper's requisites.

There is opposition to the training of more beekeepers. As soon as this is mentioned, overproduction and overstocking are brought forward to overwhelm the suggestion. The industry can be increased ten times before these things become serious for the nectar is available, the consuming public will purchase the products and the nature of the business justifies the increase. We should not neglect our duty because of criticisms due to ungrounded and selfish fear.

If commercial beekeeping should decline it would be useless for agricultural colleges to continue courses in beekeeping. Furthermore, the college authorities are justified in asking for results and unless the departments of beekeeping can produce commercial beekeepers there will be reason to look for a curtailment of funds for the work. A man teaching Greek is not supposed to produce Greeks, but in vocational training tangible results are expected. While some students take beekeeping for use in horticultural work, they add little to beekeeping and could easily get what information they need elsewhere. Their problem would scarcely justify the giving of courses.

It is too much to expect the college teachers of beekeeping to keep up the supply of professional beekeepers, for the relatively few who go to college are not all expecting to make beekeeping their life work. There must be some way of reaching the majority who do not go to college and for this we must try extension work. This is not the phase of beekeeping education that I desire to discuss at this time. But of those who do go to college there are some who are better fitted for beekeeping than for any other work, provided a fair living can be made from the business. Unless this is true, there is no hope for the future of the business. With the increased cost of the necessities of life and our transfer of former luxuries into the class of necessities, beekeeping must be made still more productive or the right type of men will not take it up. Formerly many a beekeeper lived on the products of 100 colonies; few would voluntarily do that today. With a relative decrease in honey prices this becomes still more difficult.

If beekeeping is properly practiced, it will produce an income more than adequate for the average American family. There are many beekeepers who are accomplishing this. If the majority of beekeepers are not making enough from their bees to keep a family of the better class, this may be due either to ignorance of proper methods or inability to do the necessary work. The chief deficiency is a failure to systematize the work. Many beekeepers are loaded down with non-essential details and miss the essentials; in fact most beekeepers fail to systematize their work until they are compelled to do so when they run out-yards.

If this is a defect in the practice of the average beekeeper, this may well serve as a clue to the teacher. Beekeeping has been taught for so short a time that the courses are not standardized and it is often a problem what to omit or to include and especially what to emphasize. The beekeeping literature is full of "kinks" and "tricks of the trade" but the work is not well analyzed and systematized in our literature. Small wonder then that the man assigned to give a course in beekeeping often does not know where to begin. Obviously this defect of our literature should be remedied for the sake of the practical beekeeper even more than for the teacher and student.

Every course in a college, whether vocational or strictly cultural, should have cultural value. The educational value of a course devoted to details of practice is very little unless the details are systematized and unless the reason for every step is made clear by a discussion of fundamental principles. A thoroughly practical course that is completely systematized has fully as much cultural value as the courses which are avowedly given for cultural benefits.

The work in a commercial apiary is simple, not complex. It is only the confused beginner who manipulates excessively and does

complex things. If four years is enough for medical training, surely in one year a bright boy ought to be able to learn beekeeping as practiced in commercial apiaries and be able to take care of several hundred colonies. The beekeeping course may not give all the practice needed because of the limited number of colonies usually available, but this can readily be overcome by a summer in a commercial apiary, just as the medical student gets hospital experience. After this extensive beekeeping should be practiced. Of course not all beekeepers manage their apiaries correctly but a beekeeper producing comb-honey in out-apiaries is usually not far wrong. With the proper foundation, the student will be able to detect defects in practice. We have all seen men of less than average mental ability who have learned this work, so it is not exceptionally difficult. The old advice to begin with a few colonies and work up slowly is fine for amateurs but does not make professionals.

Are such results being accomplished in the college courses? It may be too soon to demand results but the purpose of the work seems not to be in this direction in all cases. If there is a remedy it lies in a readjustment of the work so that the fundamental principles are learned. Then when it comes to practical work the essentials must be emphasized while the non-essentials and petty details of individual systems of management are ruthlessly cut out.

The teacher of beekeeping will be tempted to give interesting things in the course, as are all teachers. You will be tempted perhaps to overemphasize apparatus because of its availability for laboratory work. You will be frightened perhaps by criticism of present beekeepers against making more beekeepers. However, our industry and your positions depend on results and there is no way to get these except through the elimination of the unfit from the courses and the placing of emphasis on the two big things that the beekeeper does. This does not decrease the interest in the work if properly presented—quite the contrary.

Beekeeping is usually part of the entomological work of the colleges and this is probably the correct relation of the work to the other courses. In the work which we did in entomology there was included considerable morphology and taxonomy. Whether this is the proper emphasis for entomology is not for us to decide, but if one is tempted to follow these lines too closely in beekeeping courses there is reason to question whether the beekeeping course should largely duplicate work which is given in the regular entomological courses. Anatomy is something which makes a good beekeeper a better, broader man but probably it does not make a beekeeper, for behavior is more closely allied to practice than is structure.

Since insect behavior is not an important part of most courses in entomology, there is good reason for giving this phase of bee life more than ordinary emphasis. This is especially desirable in view of the fundamental necessity of such knowledge to the beekeeper. It is far more difficult to outline laboratory work in behavior than in anatomy, but the teacher of beekeeping has the accumulated material from experience and investigation to suggest work of this character. A serious difficulty is that your courses do not all run into the summer, but the winter cluster, the brood diseases, the development and care of the brood, wax secretion, effects of accumulated feces, responses to changes in temperature, light and humidity are all readily studied even in mid-winter. Since the wintering problem is the most serious one which confronts the beekeeper you are justified in giving this much attention. The greatest possible amount of manipulation of bees should be provided, even though you sacrifice colonies for this purpose. Then one or two periods may profitably be devoted to the study of apparatus and by the time these things are covered it will usually be time for outdoor work, assuming that the course begins in mid-winter.

It may reasonably be assumed that my suggestions are instigated by a feeling that all the beekeeping courses are not up to the standard that I would set. While I have not had experience in teaching beekeeping, I nevertheless feel that by coöperation the present defects may be remedied. Several rather surprising experiences with former students of beekeeping in various sections of the country have induced me to say what I have said, but I prefer that my criticisms be taken as general, not specific. I trust that this first conference will be a step toward correcting deficiencies.

THE BEEKEEPING WORK IN MASSACHUSETTS[1]

By BURTON N. GATES, *Associate Professor of Beekeeping, Massachusetts Agricultural College, Amherst*

1. INVESTIGATION, under the Massachusetts Agricultural College Experiment Station.

Experiments and investigation, theoretical and practical, are being carried on concerning bee diseases, color vision of bees, wintering and beeswax, together with minor investigations in other lines.

2. COLLEGE INSTRUCTION

Two courses are offered regularly enrolled, four-year students.

Entomology 8, Beekeeping, two lectures and one laboratory weekly during the second semester. Elective, primarily for juniors but open to seniors. A text-book has not been assigned.

[1] Virtually an outline of the paper as presented.

Entomology 10, Beekeeping. A course more advanced than the previous one, designed primarily for seniors, but juniors may elect it. One lecture and one laboratory weekly during the second semester. This is virtually a seminar, hence no one text-book is used.

For students of the Ten-Weeks' Winter School. Two lectures and one laboratory period weekly.

3. Extension Work

The Extension work in beekeeping has not been definitely provided for. It includes:

An Itinerant School, meeting once in three years at Amherst, otherwise at various points in Massachusetts. When at Amherst the school is of two weeks' duration, and has a staff of four to seven lecturers and demonstrators. Time devoted, a full day for five days each week. Excursions and special demonstrations are arranged for Saturdays.

Summer School. Ten lectures and laboratory practices are offered each year during summer school.

Correspondence Course. A correspondence course is provided those who may elect it. Twelve lessons are offered, based on Mrs. Comstock's "How to Keep Bees."

Annually, during Farmers' Week, a three days' convention is provided.

The College maintains an elaborate equipment which is displayed under a large tent, at a limited number of agricultural fairs each season. It is probable that this equipment will include jointly an apicultural display from the State Board of Agriculture.

4. State Board of Agriculture

The inspection work of the state is carried on by three deputy inspectors and one chief under the direction of the State Board of Agriculture. Also, the majority of the lectures and demonstrations at the meetings of the beekeepers' societies and at their field days, are paid for from the funds of this Board. However the expenses of some grange and other lectures are borne by the institution before which they are given. The State Board of Agriculture has a series of publications, now numbering ten, designated "Apiary Series." Emergency and other demonstrations are held under the provisions of the Apiary Inspection Act.

5. Other Work

The Beekeeping Department of the College maintains a wax rendering station and has handled enormous quantities of raw material for the beekeepers of the locality. This has proven a pleasing feature of the apicultural service of the state.

It is the plan and purpose in directing the apicultural work of the state, to unify or centralize it and in so far as possible to correlate it. Thus the College and State Board of Agriculture join in certain features of the work. This is desirable from the standpoint of eliminating duplication.

THE COLUMBINE LEAF-MINER[1]

By E. N. Cory, *College Park, Md.*

Historical

This insect was first described by Hardy in the *Annals and Magazine of Natural History*, Vol. 4, p. 385, 1849 (Second Series, No. 24), under the title "XL, on the Primrose leaf miner; with notice of a proposed new genus and characters of three species of Diptera, by Mr. James Hardy."

In this paper Mr. Hardy separates Phytomyza from Chromatomyia on the basis of the shape of the pupa and the place of pupation, the latter pupating in the leaf.

It is of interest to note that considerable credence was placed on the myth, that the coming of a flying serpent was forecast by the presence of the tracery of the leaf-miner on the leaves. In the words of Hardy: "A flying serpent will poison the air, which becoming impure will cause the death of 19 out of 20 (people); and that the time will be known by this particular appearance on the leaves, which the pseudo prophet calls the reflection of the serpent."

Hardy records the insect as appearing first August 13. Very little biological data of value is recorded.

Kaltenbach records the insect in "Die Pflanzenfeinde aus der Klasse der Insekten" 1872, p. 13, placing *Phyt. albiceps* Meig., *minuscula* Gour. and *ancholiæ* Rob.-Des. in synonymy. He states that the larvæ begin to work in June following a winding course, ending in an enlarged spot and finally end their wanderings at the time of frost in the earth.

In this country Dr. W. E. Britton, State Entomologist of Connecticut, was the first to record its presence, p. 145, Report of the Connecticut Agricultural Experiment Station, 1894.

In this account Dr. Britton described the larva as a footless grub 1-16 inch in length feeding in the parenchymatous tissues. The method of pupation, in the last larval skin, attached to the leaf is stated. Several broods are suggested, since the work of the insect was observed from June 26 to frost. Destruction of the infested leaves is suggested

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[1] Contribution from the Maryland Agricultural Experiment Station.

as a control measure. The insect was found in *Aquilegia canadensis.* Two excellent figures of the work of the larva in the leaves are shown.

The substance of this article was published by Dr. Britton in *Garden and Forest,* Vol. VIII, 1895, p. 443, Fig. 61. In this article the insect was noted from the middle of May to October 11.

A brief note of the presence of the insect at Inwood, New Brunswick, N. J., was published by S. Van R. Strong, *Garden and Forest,* Vol. X, 1897, p. 278.[1]

Aldrich's Catalog of North American Diptera, under *Phytomyza aquilegiæ* Hardy, notes the original description by Hardy cited above; larva mines the leaves of *Aquilegia vulgaris;* also Coquillett Bul. 10 N. Ser. Div. 78, giving its distribution as D. C., Conn.; larva mines in nasturtium and columbine.

Coquillett's article published in 1898 records rearing eight adults from nasturtium, October 1884, others were reared July 1897, and he cites the rearing by Britton, 1894, who submitted his specimens to Mr. Coquillett for determination. Coquillett stated that *Phytomyza ancholiæ* Rob. Des., placed in synonymy by Kaltenbach, is also a pest of Aquilegias.

Melander, "Synopsis of the Dipterous Groups Agromyzinæ, Milichiinæ, Ochthiphilinæ and Geomyzinæ," *Jour. N. Y. Ent. Soc.,* Vol. XXI, No. 3, p. 271, records specimens from Illinois and Idaho in addition to the other places recorded in this paper.

Habit of the Larva

The columbine leaf-miner was first noticed in the larval stage on May 11, 1914, at the Maryland Experiment Station. These larvæ pupated three days later. In view of our present knowledge of the life-history, the eggs must have been deposited on or about the first of May.

The infestation was light but later spread to practically every plant at the Experiment Station in three widely separated localities.

The lower leaves are the first to be attacked, the first and second generations confining their attentions almost entirely to them. Later the small leaves around the flower stalks may become infested.

The larval mine gradually widens out from the beginning taking a serpentine course, frequently crossing upon itself and ending in a spot nearly $\frac{1}{8}$-inch in width. The mines are plainly visible on the upper surface as white lines but can be seen only by transmitted light in examining the lower surface.

[1] The author is greatly indebted to Dr. Britton for transcriptions of the two articles in *Garden and Forest.*

Pupæ on under side of columbine leaf.

Badly infested columbine.

Usually not more than eight to ten larvæ can be found in the three lobes of a leaf though in plants under breeding jars, as high as thirty-three larvae have succeeded in reaching the pupal stage in a single leaf.

General Statement of Seasonal History

Phytomyza aquilegiæ Hardy hibernates in the pupal stage, the first adults appearing during the last of April and the first of May. These deposit eggs about the first of May. These eggs require nearly twice as long for their development as those of succeeding generations. The second generation appears about the 25th of May, completing its life cycle about one month later. From the beginning of the second generation the broods overlap considerably, but a third generation develops about the last of June. From that time on through July and August the parasites are numerous and it is extremely difficult to find any unparasitized larvæ. Moreover, it appears that during this time the adults cease to deposit as no new mines have been found during this time. The lack of infestation during the last of July and August may be due to the fact that very few new leaves are produced by the plants at this station after July 15, until the middle of September. However, a fourth generation appears about the middle of September and winters in the pupal stage.

The Egg

The egg is oblong-oval, slightly larger at one end. It is translucent pale greenish white, sub-glossy and bears no surface markings. Length 123. x 235. microns.

The eggs are deposited in the under side of the leaves with the point sometimes directed almost at 90 degrees to the leaf surface and again they may be pushed into the tissues so far that they lie parallel with the leaf surfaces (Fig. 25*a*).

Before copulation or oviposition, the females feed, puncturing the leaves with their ovipositors in hundreds of places. The ovipositor is inserted on the upper side of the leaf and the body twisted on the ovipositor as an axis until the opening is quite large. The adult then backs away from the incision until the head comes over the opening, when she feeds on the exuding liquid.

After feeding for a time the adults copulate for a period of 40 to 50 minutes. Sometimes a female copulates a second time. They begin egg-laying very soon thereafter.

The Larva

The first stage larva is about 650 to 750 microns long when newly hatched. It is translucent and nearly hyaline, though showing some yellow bodies, apparently fat cells. The light brown chitinous mouth-

part or "rake" is prominent (Fig. 25*b*). The second day shows an increase in size to 830 microns, the color remaining practically the same except that some of the yellow bodies have disappeared. The size increases gradually until a point is reached when the larva attains a

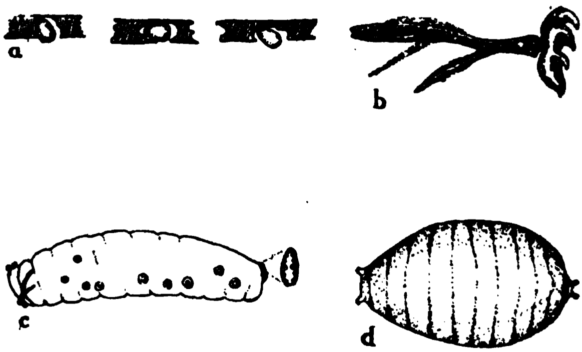

Fig. 25. Columbine leaf-miner: *a*, eggs; *b*, mouthparts or "rake"; *c*, larva; *d*, pupa.

length of 1650 microns. The full grown larva is translucent, greenish when chlorophyl is present in the alimentary tract, hyaline at other times; segmentation is not distinct. The chitinous mouthparts are dark brown to black and the tips of the spiracles light brown. There are two erect spiracles on the anterior segment and two larger widely divergent spiracles on the posterior segment. The spiracular opening presents from above, a double rosette appearance (Fig. 25*c*).

The Puparium

The puparium is nearly oval in outline viewed from the dorsal aspect. Viewed from the side, the dorsal surface presents a considerable convexity, reaching its highest point at the middle segment. Ventral surface only slightly convex. Length 1250 to 1500 microns. The anterior and posterior spiracles are at the extremities of short pedicles. Segmentation distinct (Fig. 25*d*).

The Adult

It has been thought best to draw up a revision of the original description by Hardy, since that is in a publication not generally accessible and the description is written in Latin. The present description varies only slightly from that of Hardy, particularly in regard to the color of the proboscis, which he refers to as white and the wings which he describes as hyaline.

General color dark brown to black, especially on the dorsum. Length: from tip of arista to tip of wing 2.85 mm.; from tip of arista to tip of abdomen 1.75 mm. Front yellow around ocelli, shading to black at base of antennæ. Two proclinate ocellar bristles, three orbital bristles, two pairs of verticals; oral vibrissæ short and

stout; two pairs of dorsocentrals; disc sparsely setose, two erect scutellar bristles. Abdomen setose on lateral margins. Front concave, proboscis light yellow, palpi inconspicuous, black and globular. Cheeks light brown, mesonotum shining black, pleural sutures outlined with light yellow. Wings iridescent, base of veins light yellow to white, halteres light yellow to white. Abdomen black, legs brown, yellowish at joints. Venation as in Fig. 26. Ovipositor, brown.

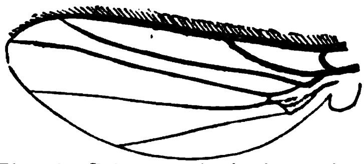

Fig. 26. Columbine leaf-miner, wing.

The Period of Incubation

The length of time required for hatching of the egg varies with the different generations. Probably the temperature is the determining factor. Eggs of the first generation require an average of 5½ days. Eggs of the second, third and fourth generations average 2 days. Averages for the year are of no value.

Length of Larval Stage

The length of larval stage seems to be less dependent on temperature than the egg stage. This is shown by the fact that the longest larval period observed in May was 11 days while in June, 12 days was the longest, with an average for the two months, however, of 10.5 days, the same as the average for May. The principal limiting factor is a reduction of the food supply such as occurs when too many eggs have been deposited in a given leaf. Under such circumstances the length of the larval period may be reduced to six days. The normal average for all generations is 10.5 days.

The Pupal Stage

The larva emerges from a crescent-shaped cut on the under side of the leaf, remaining attached thereto. In only two instances have larvæ been noticed pupating on the upper surface of the leaf. The pupal stage of the first and second generations occupy an average of 14 days. The third generation may take 19 days for the pupal stage, or, there may be a period of æstivation lasting from the first week in June to the second week in September. The fourth generation winters over as pupæ on and in the ground and the compost at the base of the plants.

Puparia, sifted from the first half inch of soil beneath plants on March 3, gave adults and parasites on April 9, in the insectary. The first individuals appeared out of doors on April 22.

Parasites

Thirteen species of parasites have been reared from the columbine leaf-miner.[1] As mentioned before, they exert a decided influence at

[1] The author is greatly indebted to Mr. A. B. Gahan for the determination of the parasites.

certain times during the year but are not able to cope with the first brood.

The parasites reared in greatest abundance were species of Closterocerus, especially *C. tricinctus* Ashm. Next in point of number was *Closterocerus utahensis* Gahan. Nine specimens of *Sympiesis agromyzæ* Gahan, nine specimens of *Diaulinus pulchripes* Crawford, seven specimens of *Diaulinus begini* Ashm., three specimens of *Derostenus varipes* Crawford, two specimens of *Derostenus pictipes* Crawford, and several specimens of *Zagrammosoma multilineata* Ashm. were reared. In addition one Pleurotropis sp., one Aphæreta sp., one Mymarid, four Chrysocharis, probably *C. parksi* Crawford and one Derostenus n. sp. were reared.

Control

Cultivation about the plants at any time after pupation of the last generation and before April 1 will undoubtedly reduce the chance of infestation. In one case, a flower bed at this Station was spaded over in early March before freezing weather was over. The columbines in this bed were entirely free from infestation by the first brood, though the previous year the infestation had been very severe. About 100 feet from this bed another plot of columbines left uncultivated until May were badly infested by the first generation. Removal and destruction of infested leaves in May before the infestation becomes general should control the depredations of the insect. No other food plants have been found though the nasturtium is recorded as a host by Coquillett. Repeated efforts to breed adults from mines in this plant have resulted in failure. The common miner of nasturtium here appears to be another species.

NOTES ON THE HABITS OF A DANGEROUS GENUS OF WEEVILS

By W. Dwight Pierce, *Bureau of Entomology, U. S. Department of Agriculture*

Recently two species of European weevils belonging to the genus Polydrusus have been found in the United States. Four other species are apparently native or have been long established. This genus is composed of very destructive species in Europe and one of the imported species is already doing considerable damage in New York and Connecticut.

Because of the possibility of further importations in nursery stock the writer has gathered together the following notes on the habits of the various species of the genus and drawn up descriptions of the stages of one of the introduced species.

Genus Polydrusus Germar

This genus was described by Germar in 1817 (*Mag. der. Ent.*, Vol. 2, pp. 339–341) and has for its type, *undatus* Fabricius, designated by Schönherr in 1826. Schönherr at this time (*Curc. Disp. Meth.*) emended the name to *Polydrosus*. LeConte and Horn in 1876 described the genus *Cyphomimus* (*Proc. Amer. Philos. Soc.*, Vol. 15, p. 105) with the type *C. dorsalis* Horn, which genus in the present conception of *Polydrusus* can only be accepted as a subgenus. The genus belongs to the Family Brachyrhinidæ Bedel, Subfamily Psallidiinæ Pierce, Tribe Polydrusini Pierce. In Europe it is subdivided into quite a number of subgenera which may ultimately be raised to generic rank if the habits of the species warrant it. Our American species have not been critically studied with a view to correlating them with the European classification.

Four species are apparently native of this country or have been long established. Two species have been recently introduced and one of these is very injurious.

Polydrusus (Eustolus) impressifrons Gyllenhal
Imported Poplar Root Weevil

This species is found in Europe on willow, especially *Salix viminalis* L., alder and hazelnut, and its variety *flavovirens* Gyllenhal is recorded from aspen (*Populus tremula*) and other trees of the genus Populus.

According to Mr. P. J. Parrott, who is making an exhaustive study of the habits of this weevil in New York:

> The beetle appears during the latter part of May and begins to oviposit immediately. The eggs are white in color and cylindrical in form. They are placed under loose bark, such as appears on the ends of broken branches or on stubs as the result of poor pruning, or in depressions or in wounded branches and trunks covered by projecting bark or even among loose bud scales of dead wood. The eggs are deposited in irregular masses containing from twenty to eighty to an assemblage. Oviposition is most active during June. The newly hatched larvæ drop to the ground and subsist on roots. They are known definitely to feed at the roots of willow, poplar and birch. Pupation takes place during early May of the following year. The beetles seem to be partial to willow, poplar and birch, but they feed on other plants among which may be listed apple and pear. Applications of arsenicals at first appearance of beetles affords efficient protection against the weevils.

The adult beetle is covered with beautiful blue-green scales. The legs are reddish. The form is brought out very clearly in Mr. Bradford's drawing.

In order to separate this species from another recent importation the following translation of the original description is given.

Polydrusus impressifrons Gyllenhal. Schönherr's Gen. et Sp. Curc., Vol. 2, p. 140.

Oblong, black, fuscous pubescent, densely clad above and beneath with green scales; antennæ and legs pallid testaceous; rostrum very short; frons impressed; femora mutic; antennal scape reaching behind eyes; funicular joints 3–7 obconical.

Similar to *P. flavipes*, but smaller, pubescence shorter and frons more flattened, subimpressed. Head rather large, subquadrate, punctulate, black, densely squamose with green scales; frons between eyes lightly impressed, with deep median puncture; eyes small, semiglobose, brown; rostrum narrower than head and half as long, similarly squamose. Antennæ slender, pallid testaceous, hardly surpassing the base of the thorax. Thorax small, transverse, basally and apically truncate, somewhat rounded at sides, lightly convex on dorsum, lightly transversely impressed near base

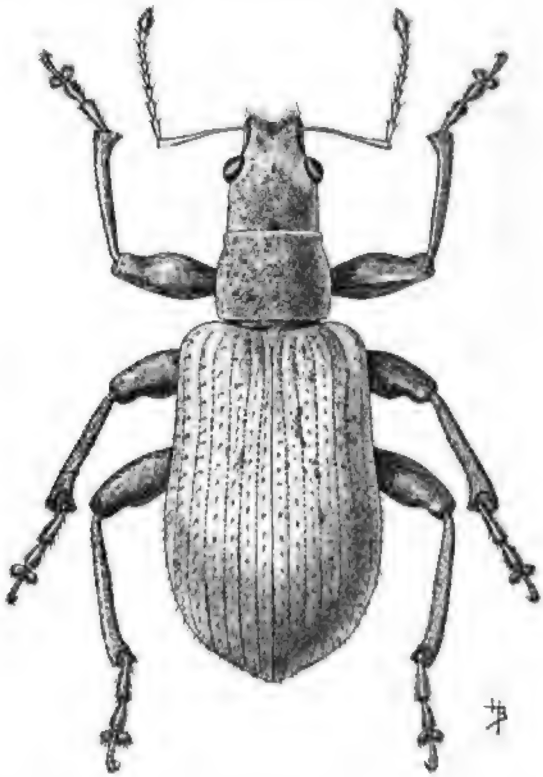

Fig. 27. Poplar root weevil, *Polydrusus impressifrons* Gyll.

and apex, punctulate, black, densely clad with green scales. Scutellum triangular, squamose. Elytra at base one-half wider than thorax; humeri elevated, almost rectangular; apices conjointly acuminate; six times as long as thorax, convex, subtly punctate-striate, interspaces broad, flat; black, covered with green scales mixed with short fuscous pubescence; interspaces sparsely and finely punctate. Body beneath punctulate, black, densely squamose. Legs rather short, pallid testaceous, cinereo-pubescent; claws brown.

Variety β. Color of scales more splendid, flavo-virescent.

Variety γ. Color of scales coeruleo-virescent.

Very careful drawings of the immature forms have been made by the writer, to aid in the field identification of the species. These are based on specimens furnished by Mr. Parrott.

Larva.—Creamy white with head slightly yellowish, but very little darker than the body. Mandibles and edge of frons darker. Length 4–6 mm. Body bristling with long setæ.

Head deeply, triangulately, emarginate at middle. Mandibles bluntly two-toothed. Margin between labrum and clypeus (post-labrum Lyonet 1762) faint. Antennæ minute, ovoid. Maxillary palpi minute, two-jointed. Labium broad obtuse, rounded at sides, terminated by a thin chitinous bow at base of stipes labii, palpi two-jointed, small, terminated by long setæ. Frons triangular, with one pair of long, very fine setæ. Epicranium with three pair of fine setæ along frontal suture and with two posterior setæ. Thorax and abdomen provided with many long setæ. Spiracles indistinct. The last segment is almost circular with the anal opening in the center and this is placed slightly in front of the apex of the abdomen. The next to the last segment has four long distant dorsal setæ and four approximate finer ventral setæ.

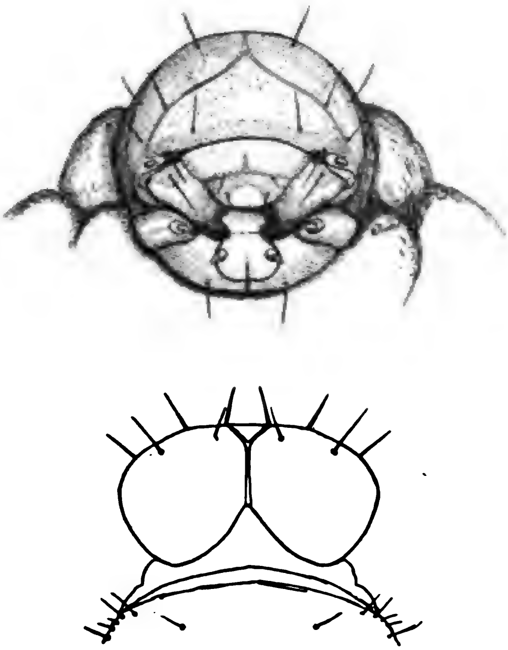

Fig. 28. *Polydrusus impressifrons* Gyll. Face of larva and dorsal aspect of larval head.

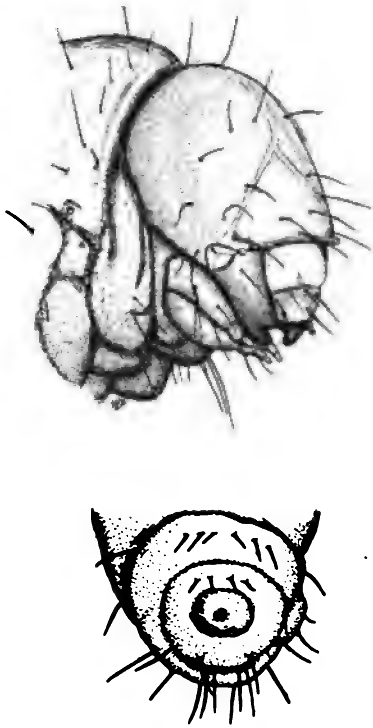

Fig. 29. *Polydrusus impressifrons* Gyll. Side view of larval head and ventral aspect of apex of abdomen.

Pupa. The pupa is characterized especially by the broad two-pronged apical segment.

Color creamy-white, eyes black. Length 4.5 to 5 mm., breadth 1.25 mm. Dorsally and laterally sparsely bristling with setigerous tubercles. Beak short, robust, enlarged at mandibles, near median line with three pair of setæ. Eyes placed closer together than width of beak. Between and above each eye are four setæ

arranged in a curve equidistant from the eye. The head is also provided with one pair of distant setæ on vertex. Antennæ geniculate, clavate and quite long. The thorax is dorsally characterized with a pair of lateral very prominent setigerous tubercles. On the front margin between these tubercles are two pair of small setæ. A very fine hair also arises at the base of each large tubercle. About the middle are two distant setigerous tubercles which form with two sublateral tubercles a semi-circle. Mesothorax between the elytra provided with two setigerous tubercles. Metathorax also provided with a pair of tubercles which are farther apart than those on the mesothorax. First seven abdominal segments with three pair of dorsal setigerous tubercles on each segment, arranged so that they make six longitudinal series of tubercles. In addition to these dorsal tubercles, each segment is provided laterally with several tubercles. Eighth dorsal segment with only four tubercles. The ninth segment is the apical segment dorsally. This is provided at its outer corners with two long inward curving processes which are semi-acute at apex. Ventrally the body is not provided with tubercles nor setæ except near the base of the sides of the ninth segment. At these places are to be found the longest setæ of the body. The arrangement of the ventral folds of the last segments is better described by means of the accompanying illustration, than can be stated in words. Each femur is apically armed with three setæ.

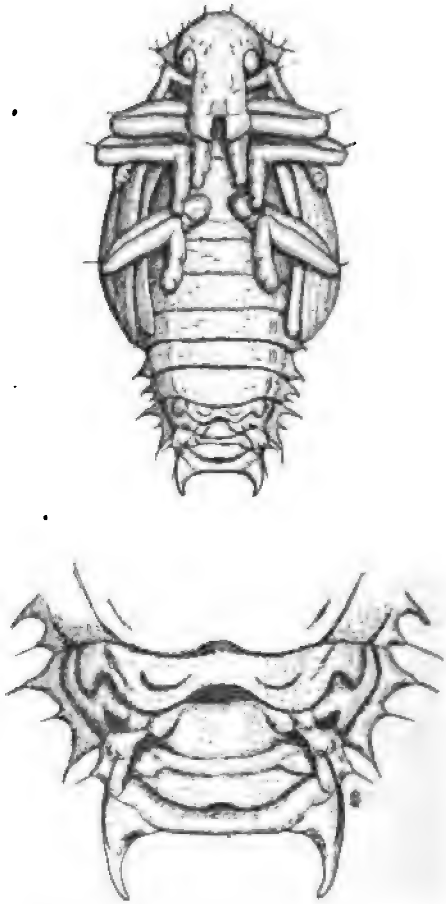

Fig. 30. Ventral view of pupa of *Polydrusus impressifrons* Gyll., with enlargement of posterior extremity.

Polydrusus (Thomsoneonymus) sericeus Schaller

Imported Fruit Bud Weevil

This weevil is one of most recently discovered importations. Two specimens have been examined which were collected in Marion Co., Indiana. In Italy this species is quite injurious as an adult to the buds and foliage of fruit trees, especially the pear, and is also found on plum, hawthorn (*Cratægus oxyacantha*), beech, and dogwood (*Cornus*

mas). In Saxony it is common on willow (Bargagli,[1] p. 59); in France on hazelnut, oak and willow (Bedel,[2] p. 242); also on alder, hazelnut, plum (*Prunus spinosa* L.), apple and beet (Kleine,[3] p. 104).

The species is slender, and beautifully covered with green scales. It very closely resembles *impressifrons*.

A technical description translated from Fahræus, follows:

Polydrusus sericeus Schaller. Acta Hal., Vol. 1, p. 286; Gyllenhal, Schönherr's Gen. et Sp. Curc., Vol. 2, pp. 148, 149; Fahræus, Schönherr's Gen. et Sp. Curc., Vol. 6, pt. 1, p. 450.

Oblong, black; clad with rounded opaque green scales; antennæ and legs pallid testaceous; beak longer, frons lightly canaliculate; elytra moderately punctate striate, interspaces flat; scape of antennæ attaining but not passing eyes, funicular joints 3–7 obconical.

The Habits of Other Species in the Genera

The records presented herewith are all that can be found concerning the habits of these destructive weevils.

The notes indicate that they lay the eggs in masses, that the larvæ seek their food, and that they feed on roots and pupate in the ground. The only exception is *cervinus*, reported to breed in leaf rolls.

Polydrusus delicatulus Horn occurs in lower California.

Polydrusus peninsularis Horn also occurs in lower California.

Polydrusus corsicus Tournier of Corsica feeds as an adult on the buds in various plants, especially the oaks (*Quercus ilex* and *Q. suber*).

Polydrusus viridicollis Baudi does considerable damage at times to the foliage and epidermis of new growth of ash (*Fraxinus*), *Cytisus*, the oak (*Quercus cerris*) and maple (*Acer*). The adults drop when disturbed (Bargagli, p. 60).

Subgenus Cyphomimus Horn

Polydrusus (*Cyphomimus*) *americanus* Gyllenhal (*dorsalis* Horn) has been beaten from budding oak by Popenoe, found on the plum (*Prunus virginica*) by Jülich, and collected on many bushes by Hamilton. Occurs in Ontario, New York, West Virginia, Maryland, Ohio, Michigan, and Kansas.

Polydrusus (*Cyphomimus*) *ochreus* Fall is common on scrub oak at Cloudcroft, New Mexico.[4]

Subgenus Chærodrys Duval

Polydrusus (*Chærodrys*) *setifrons* J. Duval of Europe lives on oak (*Quercus ilex*) (Bargagli, p. 59).

Polydrusus (? *Chærodrys*) *moricei* Pic of Europe was taken on young shoots of oak.[5]

Subgenus Metallites Germar

The insects of this subgenus live on Rosaceæ and Amentaceæ, particularly *Quercus* and *Betula*, and some of them on Conifers.

Polydrusus (*Metallites*) *impar* Gozis (*mollis* Germar) of Europe feeds as an adult on the young foliage of oak (*Quercus suber* L.), pines (*Pinus silvestris* L., *P. pinea*),

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[1]Bargagli, P., Rassegna Biologica Rincofori Europei, 1883–8.

[2]Bedel, Faune Basin Seine, 1888.

[3]Kleine, Ent. Blätter, 1910.

[4]Cockerell and Fall, Trans. Am. Ent. Soc., Vol. 33, 1907, p. 212.

[5]Pic, L'Echange, 1903, Vol. 19, p. 123.

and fir (Bargagli, p. 56); spruce (*Picea excelsa* Lam.), larch (*Larix europaea* L.), the fir (*Abies pectinata* D.-C.), and the oak (*Quercus pedunculata* Ehrh.) (Kleine, p. 103).

Polydrusus (*Metallites*) *atomarius* Olivier (*laricis* Chevrolat) of Europe feeds as an adult on the leaves and buds of larch, pine and fir (Bargagli, p. 56); *Pinus silvestris* L., spruce (*Picea excelsa* Lam.), fir (*Abies pectinata* D.-C.), beech (*Fagus*), hornbeam (*Carpinus*), oak, and willow (*Salix viminalis* L.) (Kleine, p. 102).

Polydrusus (*Metallites*) *marginatus* Stephens (*iris* Olivier) of Europe is believed to breed in the dead roots of cedar (*Juniperus communis* L.). The adults feed on the foliage and buds of the oaks (*Quercus robur pedunculata* Ehrh., *G. robur sessiliflora* Sal., *Q. cerris* L., and *Q. ilex* L.), birch (*Betula*), cedar, beech, *Erica arborea*, *Calluna vulgaris*, alder (*Alnus*) and hazelnut (*Corylus*) (Bargagli, p. 56); and pine (*Pinus silvestris* L.) (Kleine).

Polydrusus (*Metallites*) *parallelus* Chevrolat has been found in Sardinia on the buds of *Atriplex* (Bargagli, p. 56).

Polydrusus (*Metallites*) *elegantulus* Boheman (*pistaceæ* Kiesenwetter) in Greece is found on *Pistacia lentiscus* (Bargagli, p. 57).

Polydrusus (*Metallites*) *pirazzolii* Stierlin in Italy is found in May and June on oak and hornbeam (Bargagli, p. 57).

Subgenus Piezocnemus Chevrolat

Polydrusus (*Piezocnemus*) *chaerodrysius* Gredler of Europe lives on pine (Bargagli, p. 58).

Subgenus Chlorodrosus Daniel

Polydrusus (*Chlorodrosus*) *abeillei* Desbrochers in France lives on *Pyrus torminalis* (Bargagli, p. 57).

Polydrusus (*Chlorodrosus*) *amœnus* Germar occurs on blackberry (*Rubus vitisidæa* L.) (Kleine, p. 104); *R. idæus*, gooseberry (*Ribes*), and mountain ash (*Sorbus aucuparia*) (Schaufuss,[1] p. 1056).

Subgenus Eudipnus Thomson

Polydrusus (*Eudipnus*) *mollis* Ström (*micans* Fabricius) of Europe breeds in the ground and the adults feed on the foliage of beech (Bargagli, p. 58); hornbeam, hazelnut, beech, and willow (Bedel, p. 241); pine (*Pinus cembra* L.), birch, oak (*Quercus pedunculata* Ehrh.), and apple (Kleine, p. 102).

Polydrusus (*Eudipnus*) *cocciferæ* Kiesenwetter and its variety *creticus* Kiesenwetter lives in Greece and Crete on *Quercus coccifera* (Bargagli, p. 49).

Subgenus Thomsoneonymus Desbrochers

Polydrusus (*Thomsoneonymus*) *lateralis* Gyllenhal of Europe has been taken in June on beech (Bargagli).

Subgenus Eustolus Thomson

Polydrusus (*Eustolus*) *flavipes* DeGeer of Europe feeds as adult on tender foliage of *Geum urbanum*, and alder (Bargagli, p. 58); alder (*Alnus glutinosa* Gærtn., and *A. incana* D.-C.) and hazelnut (Kleine, p. 103).

Polydrusus (*Eustolus*) *chrysomela* Olivier in Austria is found on young beech (Bargagli, p. 58); in France on maritime Chenopodiaceæ (Bedel, p. 243); on birch (Kleine, p. 103).

Polydrusus (*Eustolus*) *confluens* Stephens occurs on various Genisteæ (*Sarothamnus*, *Genista*, *Ulex*) (Bedel, p. 242); *Ulex europæus* L., and *Genista sagittalis* (Kleine, p. 103).

Polydrusus (*Eustolus*) *cervinus* Linnæus of Europe is found in May and June on young branches of oak and birch, and is also found on beech (Bargagli, p. 57); on oak and hazel (Bedel, p. 242). The larvæ breed in leaf rolls in terminals sprigs on

[1]Schaufuss, C. Calwer's Käferbuch, 1914.

birch (*Betula alba* L.) and oak; also occurs on hornbeam, hasel and larch (*Larix europæa* L.) (Kleine, p. 104).

Polydrusus (*Eustolus*) *cervinus melanostictus* Chevrolat is said by Bouché to breed in August in the tips of oak branches where it cuts the leaves to form an involucre. This record is questioned by other authors (Bargagli, p. 57).

Polydrusus (*Eustolus*) *pilosus* Gredler (*melanostictus* Chevrolat) of Europe occurs on hornbeam (Bargagli, p. 58); on spruce (*Picea excelsa* Lam.) (Kleine, p. 103); on birch and beech (Schaufuss, p. 1057).

Polydrusus (*Eustolus*) *griseomaculatus* Desbrochers in France lives on beech (Bargagli, p. 58).

Polydrusus (*Eustolus*) *rubi* Stierlin occurs on *Rubus idaeus* L. (Kleine, p. 103).

Subgenus Polydrusus Germar

Polydrusus pilosulus Chevrolat (*mollis* Boheman, *villosulus* Chevrolat) of Europe feeds on the young foliage of oak and *Pinus pinea* (Bargagli, pp. 58, 60).

Polydrusus leucaspis Boheman (*suturellus* Chevrolat) in Corsica is found on elm (Bargagli, p. 58).

Polydrusus tereticollis DeGeer (*undata* Fabricius) of Europe feeds on the foliage of alder, pine, birch, hazelnut, and hornbeam (Bargagli, p. 59); also on beech, oaks (*Quercus pedunculata* Ehrh., and *Q. sessiliflora* Lam.), fir (*Picea excelsa*) and pine (*Pinus silvestris*).

Polydrusus ruficornis Bonsdorff (*intermedius* Zetterstedt) of Europe feeds on the foliage of birch and pine (*Pinus silvestris*) in July and August (Bargagli, p. 58); on hazel (Kleine, p. 104).

Polydrusus picus Fabricius in Germany is found on young beech (Bargagli, p. 59).

Polydrusus sparsus Gyllenhal is found on oak in Germany, on alder (*Alnus glutinosa*) in Corsica, and on *Rubus* in Italy, and has been taken hibernating under bark of *Platanus orientalis* (Bargagli, p. 59).

Polydrusus prasinus Olivier (*planifrons* Gyllenhal) of Europe feeds on foliage of birch, *Urtica* and alder (*Alnus incana*) (Bargagli, p. 59); and on oak (Bedel, p. 243).

Polydrusus brevicollis Desbrochers in Italy is found on plum (*Prunus spinosa*) (Bargagli, p. 57).

Polydrusus villosulus Chevrolat is rarely found in Spain in a forest of *Pinus pinea* (Bargagli, p. 60).

Subgenus Tylodrusus Stierlin

Polydrusus (*Tylodrusus*) *pterygomalis* Boheman (*pterygomaticus* Boheman) of Europe is found on hawthorn, willow and cherry (Bedel, p. 244); on birch, hazelnut and beech (Kleine, p. 104).

Polydrusus (*Tylodrusus*) *coruscus* Germar of Europe is found on willow (Bedel, p. 244) and on birch (Schaufuss, p. 1057).

NOTES ON ANASA ANDRESII GUÉR., AN ENEMY OF CUCURBITS[1]

By Thos. H. Jones, *Entomological Assistant, Truck Crop and Stored Product Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

Two species of the heteropterous genus Anasa have already attracted the attention of economic entomologists. These species, *tristis* DeG. and *armigera* Say., are both known enemies of cultivated

[1] Published by permission of the Secretary of Agriculture.

cucurbits in the United States, *tristis* being the more important pest. During 1915 the various stages of a third species, *Anasa andresii* Guér., were present on squash at Baton Rouge, Louisiana. The damage, while not especially severe, was sufficient to warrant a study of the life-history and habits of the species, especially since there appears to be no reference to it in the literature of economic entomology.

The following preliminary notes have been compiled from observations made during 1915 by the writer and by Mr. C. E. Smith, who has assisted in the studies concerning the life history.

Distribution of the Species

Anasa andresii was first described as *Coreus andresii* by Guérin-Meneville in 1856 from Cuba.[1] It is also known to be present in Mexico, Guatemala, Costa Rica, Panama and Colombia, and in the United States it has been reported from Florida, Texas, and New Mexico.

Description of the Stages

Egg.—When fully colored it is dull, reddish brown, the surface divided into minute hexagonal areas which, on all except the lower surface, have shallow depressions at their centers, and which are not found on the eggs of *tristis* or *armigera*. On the lower surface, in the central portion of which there is a slightly raised area or "button" by which the egg is attached to the surface upon which it is deposited, these depressions are lacking and the surface is smooth.

Five eggs gave an average length of 1.45 mm., an average width of 0.97 mm., and an average height of 0.91 mm.

First Nymphal Stage.—General color of head and thorax, and their appendages, dark reddish brown, almost black, with whitish markings. Abdomen yellowish white with two conspicuous, reddish brown dorsal tubercles. After feeding, the abdomen takes on a light green color. Whole surface of insect glistening, with scattered, stiff, black hairs, arising from small black tubercles. Antennæ about equalling body in length, with second and third joints noticeably flattened. Length of body about 2 mm.[2]

Second Nymphal Stage.—Resembling first stage. General color of abdomen light grayish green. Dorsal surface of head, thorax, and abdomen, dull, pruinose. Length about 3 mm.

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[1] Guérin-Méneville, F. E., in Historia, Fisica, Politica y Natural de la Isla de Cuba, by R. de la Sagra, vol. VII, p. 159, pl. XIII, fig. 9, 1856.

[2] Descriptions of the nymphal stages have been made from living specimens. The lengths given are average ones and were taken soon after the specimens had molted.

THIRD NYMPHAL STAGE.—Differs from second stage in that dorsal surface of head, thorax, and abdomen is for the most part light grayish green, pruinose. Flattening of second and third antennal joints not so apparent as in preceding stages. Length about 5 mm.

FOURTH NYMPHAL STAGE.—General color darker than in third stage. Third and fourth joints of antennæ slightly flattened. Connexivum more pronounced than in preceding stages. Length about 7 mm.

FIFTH NYMPHAL STAGE.—General color darker gray than in fourth stage, largely due to greater abundance of tubercles on surface of body. Dorsal surface of abdomen also differs from that of fourth stage in having two marginal black spots on each of first six segments, and black on anterior margin of seventh segment. Joints of antennæ all cylindrical. Length about 9 mm.

ADULT.—The following description has been made from mounted specimens:

General color of dorsal surface dark brown, the ventral surface somewhat lighter, of a grayish brown. Ground color yellowish brown. Surface of body and appendages (except dorsal surface of abdomen, membranous portion of primaries, and all of secondaries) thickly spotted with small black tubercles from which arise short setæ. Outer edges and median dorsal line of prothorax light yellowish brown. Anterior third of dorsal surface of connexivum of abdominal segments 2 to 6, inclusive, light yellowish brown. The remaining, dark portions of the upper surface of the connexivum of segments 3 to 6, inclusive, have spots of the same color in their centers. Spine above base of antenna not prominent, scarcely 0.25 mm. in length.

Average length of ten males 13.4 mm., ranging from 12.5 mm. to 14 mm. Average width of prothorax 4.2 mm., ranging from 3.75 mm. to 4.25 mm.

Average length of ten females 15.7 mm., ranging from 15 mm. to 16.5 mm. Average width of prothorax 5.2 mm., ranging from 4.75 mm. to 5.5 mm.

The sexes may be separated, as in the case of *tristis* and *armigera*, by the difference in the ventral surface of the terminal segments of the abdomen.

LIFE-HISTORY

The period of incubation of the egg was found to vary at Baton Rouge from seven to eleven days during June, July, August and September, in a well ventilated insectary and in outdoor cages, eight and nine days being the usual length of time during June and July.

The length of the nymphal stages varied considerably, depending no doubt upon the temperature and moisture conditions, and upon

the food supply. Two lots of nymphs were kept under observation in cages placed over squash plants in the field with the following results:

TABLE SHOWING LENGTH OF INSTARS, BASED ON RECORD FOR FIRST INDIVIDUAL

Lot	Hatched	Second Instar	Third Instar	Fourth Instar	Fifth Instar	Adult
A.............	Aug. 26	Aug. 28	Sept. 3	Sept. 7	Sept. 13	Sept. 21
B.............	Aug. 28	Sept. 1	Sept. 6	Sept. 10	Sept. 15	Sept. 25
Number of Days to Complete Instar						
A.............		2	6	4	6	8
B.............		4	5	4	5	10

HABITS

So far as observed the habits of this species are quite similar to those of *Anasa tristis* and *A. armigera*. Indeed, nymphs and adults of *andresii* and *tristis* are often found mingling together on the plants. In 1915 adults were first noted in the field at Baton Rouge on May 26 and soon afterwards eggs were found on squash. The eggs are usually deposited on the under surface of the leaves of the host plants, though they may be placed on the upper surface or on other portions of the plant above ground. They may even be laid on other vegetation or on objects in the vicinity of the food plants. They are placed in groups of varying size or even singly, fifty groups ranging in size from two to fifty eggs giving an average of fifteen per cluster. The eggs are arranged in no regular pattern and there is a tendency to place the eggs farther apart than is usual in the case of *tristis*.

Upon issuing from the eggs the nymphs cluster around the egg shells for a time but later become more or less scattered, being usually found on the under surfaces of the leaves, though they may also occur on other parts of the plant or beneath dead leaves and rubbish nearby. Oftentimes when the vines have been killed by the squash vine-borer (*Melittia satyriniformis* Hübn.), or from some other cause, the adults and the nymphs gather on any fruit remaining in the field.

The injury caused by the nymphs and adults is identical to that due to the attacks of *tristis*. Portions of the leaves from which the bugs have been extracting the juices wilt and later die, presenting the appearance of having been injured by fire.

TRIPHLEPS INSIDIOSUS AS THE PROBABLE TRANSMITTOR OF CORN-EAR ROT (DIPLODIA SP., FUSARIUM SP.)

By J. A. Hyslop, *Bureau of Entomology, Washington, D. C.*

In the fall of 1912 we were advised of a severe outbreak of insects attacking corn in Maine. The writer was dispatched to investigate this outbreak and reached New Paris, Maine, on September 20, only to find that the injury was due to a form of ear rot which was doing its most severe damage to sweet corn in the large and important corn canning districts of that state. As the various forms of ear rot are not confined to sweet corn and, as Mr. Morrill, of the Burnham & Morrill Canning Company, believed that insects were largely responsible for this damage, a preliminary investigation was undertaken. I here wish to express my appreciation of the many favors shown to me by Messrs. Burnham and Morrill at whose plant most of the experiments were carried on.

The disease first makes it appearance as a small yellowish discoloration of that part of the kernel immediately about the point where the silk is attached and first appears when the corn is in the milk stage. This discoloration spreads over the entire kernel and eventually the epidermis ruptures. A viscid yellow liquid is exuded and finally the kernel breaks down into a putrid mass. The diseased areas are scattered and often run together, entirely destroying the ear. In the advanced stages of the disease, a compact white mycelium often covers the infected areas and several instances were noted wherein this mycelium had a decided pink cast. Material of this nature was sent in to Washington and was tentatively determined by the Mycologist of the Bureau of Plant Industry as *Bacterium stewarti* Erw. Sm. However, *Bacterium stewarti* is generally recorded as attacking the corn when it is very young, and when ears are infested the husk shows manifest symptoms. In the disease under consideration the husk was never damaged, the disease not being detected until the corn was husked. The second shipment of this material with brief notes was determined as *Fusarium spp.* or *Diplodia sp.*, the material being in too poor condition for exact determination. I am quite convinced, from the symptoms described by Burrill and Smith, that *Diplodia* is the actual causative agent. The cause of the disease, however, was not the phase of the problem that immediately interested us. Its method of transmission was the important entomological problem.

Fresh corn ears in the milk stage were used in the following experiment. The ears were carefully gathered from an uninfested field.

Forty ears were used in this experiment: ears Nos. 1–10 were punctured with a clean, heat sterilized, needle; Nos. 11–20 were punctured with a needle moistened with clean tap water; Nos. 21–30 were not punctured but were simply moistened on the outside of the kernels with a solution of the disease, and Nos. 31–40 were punctured with needles infected with the disease. In puncturing the kernels the husk was pulled back from part of the ear and a single row of kernels punctured. Sterile tissue paper was then placed over the exposed kernels and the husk replaced and fastened with a rubber band. The only case wherein we got infection was in the last series of ten ears, those infected by puncturing the epidermis of the kernels with infected needles. The day following the infection, a characteristic yellow discoloration was noticed around the point of infection in every kernel in the row infected. The second day following infection, the kernels were generally discolored and on the third day the epidermis of many had ruptured with the characteristic viscid exudations. This seemed to indicate that it was necessary that this disease should gain access to the kernel by means other than air-borne spores alighting upon the exposed tips of the ears, which was the theory advanced by several packers in this region, and that it was transmissible by subcutaneous injection. The only natural methods that suggested themselves to the writer, were a root infection of the plant by which the disease gained access to the corn through the fibro vascular system, or an infection caused by the injury of the kernel by some insect which had previously been infected with the disease. A careful search was made in many of the worst infested fields and the only insect which seemed at all likely to be able to gain access to the corn within the husk was the small Heteropteron, *Triphleps insidiosus*. Large numbers of these insects were found in the fields where the disease was worst. They were in the silk, under the husk, and in the litter about the bases of the plants. As the season was then well advanced and the corn crop was pretty well harvested, further field experiments with the insect were not possible. Since that time we have received no complaints of this disease attacking field corn and other problems have engrossed our time. Most of these diseases caused by *Diplodia* and *Fusarium* are supposed to pass the winter in the plant refuse and on the ground in the fields and thus to reinoculate the ensuing year's crop.

In 1914 Messrs. H. Garman and H. H. Jewett[1] published a short account of *Triphleps insidiosus* as a beneficial insect feeding on the eggs of corn-ear worm, *Chloridea obsoleta*. In this account they very minutely record their data on the egg laying of this insect. During the latter part of August the eggs are laid in the corn silk and hatch

[1]Ky. Agri. Exp. Sta., Bul. 187, p. 587.

in about three days, the insect reaching maturity in about fifteen days. As this insect is known to hibernate in the rubbish in the corn fields, the conclusion at which I have arrived is almost evident: The insects spending considerable of their time in the rubbish in the fields become infected with the disease, they oviposit in the corn silk, infection enters at the point of oviposition and travels down the corn silk to the ovary of the corn. The evidences in favor of this conclusion are: the characteristic starting points of discoloration of the kernel at the base of the corn silk, the fact that the disease will occur on several points of the ear often distant from the tip, and that the disease is not one of the forms which attack the plants through the roots and fibro vascular system nor can be introduced by air-borne spores alighting upon exposed parts of the ear. In fact, in many cases ears were badly rotted wherein the husk was tight and extended considerably beyond the tip of the ear.

Should this hypothesis prove to be the fact, *Triphleps insidiosus* will assume quite a different rôle than it has assumed in the past. It has been recorded as a very beneficial insect as far back as 1881 when Riley[1] recorded this insect as a natural enemy of *Blissus leucopterus*. In 1900 Dr. S. A. Forbes[2] gives this insect as a natural enemy of *Blissus leucopterus*, *Phylloxera*, *Thysanoptera*, eggs of *Heliothis obsoleta* and larvæ of *Diplosis sorghicola*, and Garman and Hewitt add *Coccidæ* and *Aleyrodes vaporarium*. As a noxious insect, this is not the first record by any means. It has been recorded as damaging plants as far back as 1888 in an unsigned article published in Garden and Forest, August 22, wherein it was stated that many of the Chrysanthemum collections around Boston were being seriously damaged by this insect piercing the ends of the shoots and causing the leaves to curl up and wither. Dr. E. P. Felt[3] records this insect as doing damage to squash vines, and Professor Herbert Osborn found them damaging the blossoms of red clover. It is possible that the injury in these cases is purely physical, destroying the plant tissue by withdrawing the sap. It is not impossible, however, that, in these cases also, parasitic fungi introduced by the mouthparts or ovipositor of the insect were largely responsible for the destruction of the plant tissues.

The probability of the transmission of *Diplodia* and *Fusarium* by *Triphleps insidiosus* serves to accentuate the remedial measures generally suggested in combating these diseases; not replanting fields to corn that have borne a diseased crop, and destroying the leaves and stubbles in all infested fields. It is not even advisable to use this litter

[1] Amer. Agri. Tec. 1881, Vol. 40, p. 515.
[2] Bul. 60, Ill. Agri. Exp. Sta.
[3] Am. Garden, Sept. 10, 1898.

as stock feed, as the pile of fodder would undoubtedly serve as a hibernating place for these insects. Probably the most advisable procedure would be to cut the corn with as short a stubble as possible immediately after gathering the crop and burn it in wind rows in the infested fields. Then fall plow the field, plowing as close to the fences as possible to destroy possible hibernation quarters.

SARCOPHAGIDÆ OF NEW ENGLAND: GENUS SARCOPHAGA

By R. R. Parker

Sarcophaga aldrichi, n. sp.

Type ♂: Massachusetts Agricultural College.

Paratypes (♂): Massachusetts Agricultural College, one; United States National Museum, two (No. 19165); Boston Society of Natural History, one; Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., three; collection of Dr. J. M. Aldrich, one; collection of author, one.

(♂) Vestiture of both thorax and abdomen hairy throughout; only presutural pair of anterior acrostichals present, weak; anterior femur with but two rows of bristles, an upper and a lower, or, if present, bristles of intermediate row are very slender and hair-like; posterior face of posterior tibia with a row of scattered long hairs on distal half; second genital segment black or blackish.

Length.—8½ to 11½ mm.

Head.—Viewed from side parafrontals and genæ with dark reflections, transverse impression sometimes with a reddish tinge. Breadth of front at narrowest part about one half eye width; cheek height approximately one half that of eye. Front prominent; sides of frontal vitta converging backward by straight lines, rarely parallel. Second antennal segment dark; third about twice length of second; arista plumose on basal half or slightly more. Back of head somewhat convex with three or four rows of black cilia behind eyes, otherwise clothed with yellowish white or whitish hair that completely covers metacephalon. Cheeks clothed with black hair. Genæ clothed with scattered hairs. Palpi dark.

Chætotaxy.—Lateral verticals absent; vibrissæ sometimes inserted on line of oral margin, but usually very slightly above.

Thorax.—Metanotum clothed with fine, erect hair that is sometimes quite long. Hairs covering anterior spiracle dark basally, lighter toward tips; those of anterior margin of posterior spiracle dark brown; those of spiracular cover brownish with yellowish tips. Epaulets dark.

Wings.—Bend of fourth vein normally a right angle; anterior cross-vein more basal than end of first longitudinal; third vein bristly; costal spine vestigial; section III of costa slightly greater than section V; alulæ fringed with hairs; calypters whitish, margins fringed with whitish or slightly yellowish hairs.

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[1] Contribution from the Entomological Laboratory of the Massachusetts Agricultural College.

Legs.—Dark. Posterior trochanter without "brush" or latter so small as not to be distinguishable as such: femur cylindrical or sub-cylindrical, clothed beneath with medium long, scattered hair; anterior face with three rows of bristles, those of intermediate row shortest and not developed distally; posterior face without ventral row of bristles: tibia straight or slightly curved, a row of scattered, long hairs on distal half of lower posterior face: tarsus equal in length to tibia, fourth segment at least one half fifth. Middle coxa with a single row of bristles: femur clothed beneath on posterior, proximal half with fine, but rather short hair; anterior ventral row of short bristles complete, posterior row represented by "comb" on distal one-third to two-fifths: submesotibial bristle present. Anterior coxa with two rows of bristles; femur usually with two rows, but if three are present, intermediate row consists of very fine, hair-like, scarcely distinguishable bristles.

Chætotaxy.—Bristles usually long and slender. Anterior dorsocentrals, as a rule, scarcely shorter than posterior; only presutural pair of acrostichals developed, slender, others rarely present and if so, very hair-like; inner presuturals slender, nearly as long as anterior dorsocentrals: four pairs postsutural dorsocentrals; prescutellar acrostichals present: scutellar apicals present: sternopleurals, sometimes both sides with three or two but very commonly two on one side, three on the other: lower sternopleura with a single row of bristles, otherwise with long hair.

Abdomen.—Somewhat conical or slightly oval; hairy vestiture longer and finer beneath Ventral plates, as a whole, with their sides slightly converging posteriorly, almost parallel; at sides vestiture long on all three, but centrally vestiture of third shortest and erect.

Chætotaxy.—Second segment usually without marginal bristles, at most they are hair-like and decumbent; third with two and often with weaker, hair-like bristles between these and laterals; fourth with complete row ending ventrally in long hairs.

Genital Segments.—Not conspicuous, normally but small part of first showing, often only membranous band joining the segments. First (g. s.$_1$) ground color varies from brownish orange to blackish, grayish pollinose except "humps" which are not differentiated, vestiture about equal in length to that of second, in profile slightly arched, marginal bristles absent: second (g. s.$_2$), rotund, anal area flattened and extending about to upper limit of posterior surface; shining black, often faintly grayish pollinose, sometimes with a brownish tinge. Forceps, normally not visible, blackish brown or orange brown; prongs flattened, their inner edges meeting ridge-like for more than two thirds their length then separated, but tips so bent that edges normally meet just before the extremities of prongs, the latter spreading slightly, vestiture increases in length and amount basally; base with upward flap-like extensions. Connecting membrane just anterior to "humps" with a row of long, slender hairs on each side.

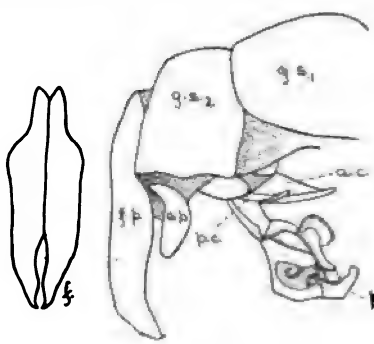

Fig. 31. *Sarcophaga aldrichi*, genital segments.

Genitalia.—Heavily chitinized portions of head of penis (p.) black or blackish: anterior claspers (a. c.) broad and flattened: accessory plates (a. p.) brownish orange, hairy, and with an almost linear extension that parallels forceps for a way. Inner edges of lamellæ of fourth ventral plate fringed with hairs. (p. c. = posterior clasper.)

(♀) Not definitely known.

Described from 11 male specimens, 71 others examined.

Range.—New England: Mass.; Wellesley, Westfield, Melrose Highlands, Harwich, Forest Hills, Lunenburg.

United States: N. Y.

Foreign: Canada (Quebec).

This species is named in honor of Dr. J. M. Aldrich.

The bristles are long and slender, except on the legs. It is peculiar that the left sternopleura often bears two sternopleurals, the right one three, while in none of the specimens examined was the reverse condition found. The rows of cilia should be counted on that portion of the back of the head which is nearest the epicephalon. In exposing the genitalia the forceps are likely to be spread and flattened out so that they do not appear normal.

S. aldrichi is extremely similar to *S. uliginosa* Kramer. Though the penes are distinctive, those external characters which have a differential value are somewhat variable. The most constant distinctive character seems to be the presence of a row of long, scattered hairs on the distal half of the lower posterior face of the hind tibia, while in *S. uliginosa* the hairs are close set and form a distinct beard on the distal three-fourths. The number of rows of black cilia behind the eyes, commonly a reliable specific character, varies in both species. In *aldrichi* there are usually but two rows of bristles on the anterior femur, but sometimes an intermediate row is weakly developed; *uliginosa*, on the other hand, commonly has three rows though occasionally the intermediate one is so weak as to resemble that condition in *aldrichi*. *Uliginosa* seems to constantly have three sternopleurals, in *aldrichi* the number varies. In the former anterior acrostichal bristles, except the presutural pair, are usually absent, while in *uliginosa* all are commonly present; but again this character varies in both. Though the penes are specific, the fourth ventral plates are alike, as are also the forceps.

S. aldrichi agrees with *S. uliginosa* Kramer, *S. utilis* Aldrich, *S. sarraceniæ* Riley, *S. exuberans* Pandellé, *S. harpax* Pandellé and three undescribed New England species in the absence of marginal bristles on the first abdominal segment. These bristles are sometimes absent in *S. sinuata* Meigen. It agrees with *S. uliginosa* Kramer, *S. sarraceniæ* Riley, *S. exuberans* Pandellé, *S. harpax* Pandellé, *S. hæmorrhoidalis* Meigen, *S. dalmatina* Schiner, *S. falculata* Pandellé and one undescribed species in the presence of a row of long, slender hairs on each side of the connecting membrane just anterior to the humps of the first genital segment. This is rather obscure, and interesting to show

possible relationship rather than as a convenient specific character. These hairs are always in line with the spiracles on each side and the significance of their presence is not quite clear, unless as representing the remains of the vestigial sixth abdominal segment, the so-called fourth ventral plate of taxonomy being its sternum.

Among material examined from the Gypsy Moth Laboratory at Melrose Highlands were a number of specimens of *S. aldrichi* recorded as reared from pupæ of *Porthetria dispar* (L.), collected at Melrose, Wakefield, North Saugus, Woburn, North Andover, Beverly, Essex, Topsfield, Gloucester, and Swampscott. Certain of these cities should appear under the range, but there are no means of discrimination. Of Sarcophagidæ collected at Lunenburg, Massachusetts, during the summer of 1914 by R. T. Webber of the Gypsy Moth Laboratory, this species is by far the most numerous.

I am indebted to Professor J. M. Aldrich for the following notation which he received from Professor Lawson Cæsar, Provincial Entomologist of Ontario: "In the last three years forest tent caterpillars (*M. disstria*) have been very abundant in the eastern parts of Ontario. Last year when visiting that part of the province on some entomological work, I observed that nearly 90 per cent of the cocoons opened in July showed the presence of a dipterous larva, which I supposed would be a Tachinid. However, from about two dozen of these cocoons brought back with me to Guelph there have emerged eight Sarcophagids and no Tachinids." Specimens were determined by Dr. Aldrich as *S. aldrichi*.

While examining material collected at Lenox, Massachusetts, during June, 1915, by C. W. Johnson of the Boston Society of Natural History, this species was noted to be very numerous. Conversation with Mr. Johnson established the fact that caterpillars of *Malacosoma disstria* Hübner were abundant in that locality.

Except for a few scattered specimens captured in isolated localities, the only records the writer has of the occurrence of this species in abundance have been where there were larvæ of either *Porthetria dispar* or *Malacosoma disstria*, especially the latter. The true status of this species in the economy of nature may be a point worth determination.

Scientific Notes

Forest Insect Investigations (A. D. Hopkins, In Charge). S. A. Rohwer, Bureau of Entomology, has recently completed a summary of the nursery connected with the eastern Field Station, arranging it under the heads of "Deciduous" and "Coniferous" trees.

There are twenty-six species of deciduous trees represented in the nursery by one hundred and fifty-eight individuals. Most of these are oaks and are used in experiments on leaf-feeding insects and gall makers.

In the coniferous nursery there are twenty-six species represented by one thousand three hundred and thirty-eight individuals. Four new conifers have been added to the nursery since last report. These are *Pinus scopulorum*, *Pinus edulis*, *Pinus laricio*, and *Pinus tæda*.

Since the last report one hundred and fifty-four trees have been numbered and individual observations are being kept on these trees, in connection with the experiments with the insects. Most of these trees are being used in experiments on the two recently introduced pests, *Evetria buoliana* and *Diprion simile.*

It is noted that most of the seedlings which came from the Pacific Coast had the foliage winter killed and were considerably later in commencing to grow than species from other localities. An interesting comparison can be made between the two plots of *Pseudotsuga taxifolia*. In one of these the seedlings came from Oregon and every tree showed considerable winter killing of the foliage. In the other plot the seedlings came from Colorado and there was no winter killing of the foliage of these trees.

Federal Horticultural Board. The fumigation of imported cotton is now proceeding in Boston and San Francisco in a thoroughly satisfactory manner. In the use of a substance as poisonous as hydrocyanic-acid gas in such huge quantities, there is necessarily risk unless thorough-going precautions are constantly taken. The existence of such risk has been two or three times demonstrated already in the work in Boston, with no serious consequences, however, other than the temporary disabling of workmen. In every instance, however, these accidents have resulted from carelessness and disregard of precautionary measures which have been specifically insisted upon. It is believed that this experience will control any further tendency to carelessness on the part of the workmen concerned. The investigation of the fumigated cotton by the experts of the Federal Horticultural Board, and of the Bureau of Chemistry, of this Department, has shown that after an aeration of a day or two the fumes of the gas have practically entirely disappeared, and no further danger from fumigated cotton is possible.

During the month of May the following quarantines have been promulgated:

Notice of Quarantine No. 24, on "Corn Diseases." Notice of Quarantine No. 25, "Gipsy Moth and Brown-Tail Moth Quarantine."

The corn disease quarantine prohibits the importation, in the raw or manufactured state, from southeastern Asia (including India, Siam, Indo-China, and China), Malayan Archipelago, Australia, New Zealand, Oceana, Philippine Islands, Formosa, Japan, and adjacent islands, of seed and all other portions of Indian corn or maize (*Zea mays* L.), and closely related plants, including all species of Teosinte (*Euchlæna*), Job's tears (*Coix*), *Polytoca*, *Chionachne*, and *Sclerachne*. This quarantine has some entomological importance in that, though directed against corn diseases,

it operates at the time to exclude any possible further entry of any oriental insects attacking this cereal.

The gipsy-moth and brown-tail moth quarantine embodies the annual revision of the territory, necessitated on account of changes in distribution of the two insects. Provision for the inspection and certification of Christmas trees has been continued for another year. Arrangements have also been made for notifying the proper state officials of all shipments of certified products from the quarantined territory, in order that the states may have a chance to reinspect such products if desired.

Mesogramma polita Say. On July 10, 1916, while upon a collecting trip about six miles south of the city of Baton Rouge, I came to a small field of corn which was infested by Syrphid larvæ. Taking particular notice of them, I found they were feeding upon the pollen grains which had fallen down on the leaves, and were the most numerous at the junction of the leaves with the main stalk. In that place considerable moisture remained during the entire day. Later I found that the larvæ would feed out upon the leaves during the early part of the morning as long as the dew was present but retreated to the base of the leaves as the dew disappeared.

Recalling Mr. C. H. Richardson's article upon "corn-feeding" Syrphid larvæ in the June issue of the JOURNAL, I collected a number of the larvæ and later at the laboratory reared the same by feeding them upon the pollen of corn. From the pupa emerged the adult flies of *Mesogramma polita*, Say.

Wishing to be certain of my identification I sent the specimens to Dr. L. O. Howard and they were identified by Mr. F. Knab as *Toxomerus politus*, Say. (Synon.).

O. W. ROSEWALL,
Louisiana State University, Baton Rouge, La.

Report on Gipsy Moth Conference held in Boston and Vicinity, July 7 and 8, 1916. A summer conference on gipsy moth work was held on July 7 and 8 for the purpose of visiting different sections of the infested territory and observing the methods used in the field and at the Gipsy Moth Laboratory. The following visitors were present: Mr. L. S. McLaine, Fredericton, N. B.; W. A. Osgood, Durham, N. H.; F. W. Rane, Boston, Mass.; George A. Smith, Boston, Mass.; R. L. Kneeland, Boston, Mass.; H. T. Fernald, Amherst, Mass.; J. J. Pillsbury, Providence, R. I.; Harry Horovitz, Providence, R. I.; I. W. Davis, New Haven, Conn.; George G. Atwood, Albany, N. Y.; C. L. Marlatt, Washington, D. C.; W. E. Hinds, Auburn, Ala., and Alden T. Speare, Washington, D. C.

The members of the staff of the Bureau of Entomology connected with moth work also attended the meeting and field trips. The visitors assembled at the office of the Bureau of Entomology, 43 Tremont Street, Boston, at 10 o'clock and proceeded to Plymouth, Mass. In the afternoon a number of badly infested areas were inspected in the town of Plymouth and vicinity. The night was spent at Plymouth and in the morning the party proceeded to the Bussey Institution at Forest Hills, where an inspection was made of the work which is being carried on in regard to the wilt disease of the gipsy moth. In the afternoon a demonstration was given of high-power spraying with the automobile truck sprayer of the Bureau of Entomology. The party then proceeded to the Gipsy Moth Laboratory at Melrose Highlands, and examined the work which is being carried on there.

The meeting was called for the purpose of giving an opportunity of seeing the field conditions and field work, hence no papers or reports were given.

Those who attended expressed much satisfaction at having an opportunity to see the work during the time when the caterpillars are the most destructive.

A. F. BURGESS

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The meeting of the Pacific Slope Branch will be held just after the forms for this number are closed and much too late for any notice in this issue. We take this opportunity of extending best wishes to our Pacific Slope members and to express the hope that the San Diego meeting may be a most pleasant and profitable one.

The Nova Scotia Entomological Society, a branch of the well known Entomological Society of Ontario, was organized in August 1915. The recently issued proceedings (No. 1) of this organization contains valuable articles relating to both economic and systematic entomology and may be taken as an earnest of a long and successful career. The accounts of injury to apple trees by the false tarnished plant bug and the date relating to the apple maggot are particularly interesting to the economic entomologist.

The food value of insects, as pointed out by one writer in this issue, is most certainly worthy of investigation. Many species are very abundant under certain conditions and if methods of collecting and preparing them for food are well understood, it would mean much for many in moderate circumstances and there is the possibility that studies along this line would not be without significance for the epicure. There is not only an opportunity to take advantage of the unusual numbers of insects which now occur under natural conditions

or at least without intentional assistance from man, but the short life cycle and the great prolificacy of certain insects suggests the possibility of using some forms as an agent in rapidly transforming comparatively worthless materials into a food possessing not only nutritious but appetizing qualities. In other words, there are possibilities in rearing insects for food as well as for the production of honey, dyes or silk deserving careful attention.

Aphis or Aphid. The undersigned have carefully considered the question raised by Dr. Chittenden as to the use of the words "plant lice," "aphid," etc., in publications of the Bureau of Entomology. It appears that the following terminology relative to common names of species of Aphididæ should be adopted in Bureau publications:

(1) Aphis should be used in connection with some other modifying word as, the "wooly apple aphis," "corn aphis," "box-elder aphis," etc. This conforms to the practice adopted by the American Association of Economic Entomologists.

(2) The word "aphid" or "aphids" (plural) should be used in referring to plant lice in general. While the origin of the word "aphis" is unknown it has apparently been latinized and should properly be rendered in English, as Dr. Chittenden suggests, as aphidid or aphides. However, since the word "aphid" is given preference in most dictionaries, and is almost exclusively used by students of Aphididæ, it does not seem good policy to attempt to change a practice so well fixed.

As regards the use of the word "plant-louse," this should be abandoned and "aphid" employed in its place.

C. L. Marlatt
A. L. Quaintance
W. D. Hunter

Notes on the Distribution of the Clover-Leaf Weevil (*Hypera punctata* Fab.) **in Kansas.** In his paper "The Genera Hypera and Phytonomus in America, North of Mexico" (*Ann. Ent. Soc. Amer.* 1911, Vol. 4, pp. 383–473), Titus records *Hypera punctata* Fab. from North Topeka, Kansas. In so far as the writer can learn this is the only record of this species being taken in Kansas.

While investigating a cutworm outbreak in alfalfa near Independence, Kansas, on May 25, 1914, the writer found three adult clover-leaf weevils under a small pile of alfalfa. On June 4, 1914, while engaged in similar work near Leavenworth, Kansas, over one hundred specimens of this insect were found under a pile of alfalfa.

On June 13, 1916, while collecting insects at Manhattan, Kansas, on submerged vegetation following a heavy rain, the writer found three clover-leaf weevils clinging to heads of peppergrass. Since then one of the collectors for the department has collected specimens of this insect in limited numbers from widely separated fields in the vicinity of Manhattan.

These collections show the clover-leaf weevil to be present in Eastern Kansas in widely separated localities, ranging from the northern to the southern parts of the state. The infestation also extends into the state to a distance of at least one hundred twenty-five miles.

James W. McColloch, *Assistant Entomologist,*
Kansas Agricultural Experiment Station

Current Notes

Conducted by the Associate Editor

Mr. W. F. Fiske, who is now in London, has written that he will be in the United States on the 15th of July.

Mr. A. H. Robinson has been appointed field assistant in the Bureau of Entomology with headquarters at Plymouth, Ind.

According to *American Fruits*, "Dr. A. J. Cook, formerly Horticultural Commissioner of California, is seriously ill of cancer."

Geo. S. Demuth, Bureau of Entomology, is at Fennville, Mich., continuing his work on the effects on bees of spraying fruit trees.

Mr. R. M. Garner has been engaged by the Bureau of Entomology to assist in work on truck crop insect investigations at Norfolk, Va.

Mr. Wm. N. Ankeney, from Ohio State University, is field assistant of the Bureau of Entomology, and stationed at Big Rapids, Mich.

Mr. August Busck, of the Bureau of Entomology, has been granted leave of absence to make a short visit to his old home in Denmark.

B. R. Coad, A. C. Morgan, and D. L. Van Dine, of the Bureau of Entomology, were in Washington for conferences during the month of May.

Mr. A. D. Borden, of the Bureau of Entomology, recently visited some large growers of greenhouse plants in Maryland, Pennsylvania, and New Jersey.

Dr. C. H. T. Townsend, of the Bureau of Entomology, accompanied by Carl Heinrich, made an extensive collecting trip in New Mexico during July.

Professor J. H. Comstock has been elected as one of three delegates to represent the faculty of Cornell University at the meeting of the board of trustees.

Dr. L. O. Howard left Washington on June 5 for a trip of about six weeks' duration to the southern and western field laboratories of the Bureau of Entomology.

Mr. James I. Hambleton, of the University of Wisconsin, has been appointed field assistant of the Bureau of Entomology, and will be stationed at Madison, Wis.

According to *Science*, Dr. David D. Whitney has been appointed professor and Professor Homer B. Latimer associate professor of geology at the University of Nebraska.

Professor Herbert Osborn, of the Ohio State University, is engaged in special research at the Agricultural Experiment Station, Orono, Me., during the summer vacation.

Mr. A. T. Speare, Bureau of Entomology, made a short trip to Hagerstown and Smithsburg, Md., in connection with observations on a fungous disease of *Eulecanium nigrofasciatum*.

Mr. G. W. Barber, of the Bureau of Entomology, recently attached to the Charleston, Mo., field station, has been transferred to the range-caterpillar work, located at Maxwell, N. Mex.

Mr. Harold Westcott has been engaged by the Bureau of Entomology as assistant to D. E. Fink at the Virginia Truck Experiment Station, Norfolk, Va.

The seventh annual field meeting of the Connecticut Beekeepers' Association was held at the Connecticut Agricultural College, Storrs, Conn., August 3 and 4.

Mr. James K. Primm, of the University of Illinois, has been appointed to assist D. Isely at North East, Pa., in grape-insect investigations of the Bureau of Entomology.

Mr. F. A. Johnston, Bureau of Entomology, is in charge of the field station at Big Rapids, Mich., his former headquarters at Hart, Mich., being retained as a substation.

Mr. W. D. Pierce, Bureau of Entomology, is on an extended trip to determine the status of the boll weevil, especially in the regions which were invaded for the first time last season.

Mr. E. R. Selkregg, of the Massachusetts Agricultural College, has been appointed to assist H. G. Ingerson at Sandusky, Ohio, in grape berry-moth investigations of the Bureau of Entomology.

On June 7, 1916, Tulane University conferred the degree of Doctor of Laws upon Dr. W. D. Hunter, in charge of the Southern Field Crop Insect Investigations, of the Bureau of Entomology.

Mr. G. F. Ferris, assistant in entomology at Stanford University, is temporarily located in Washington, D. C., and is devoting considerable time to the study of Coccidæ with Harold Morrison.

Mr. J. J. Pillsbury, scientific assistant at the Gipsy Moth Laboratory of the Bureau of Entomology, has recently resigned to accept the position of Assistant State Entomologist of Rhode Island.

The states of Idaho and Wisconsin have recently announced a quarantine as regards certain species of pines from the Northeastern States where the white pine blister rust is known to occur.

Mr. C. M. Packard, of the Bureau of Entomology, recently inspected the Sacramento Valley of California in search of Hessian fly and reports that the pest is apparently absent there at this time.

Messrs. T. P. Cassidy and W. B. Williams, students in the Mississippi Agricultural College, have been appointed temporary field assistants of the Bureau of Entomology under B. R. Coad at Tallulah, La.

Messrs. Hunter H. Kimball and James F. Curry have been appointed temporary field assistants of the Bureau of Entomology for assignment to the malaria mosquito investigation under Dr. D. L. Van Dine.

Mr. A. C. Baker, Bureau of Entomology, has been visiting orchards in the vicinity of Crozet, Staunton, and Winchester, Va., making observations on certain apple aphids, especially *Aphis malifoliæ* Fitch.

Mr. E. B. Pence has been appointed an assistant for temporary service at the laboratory at Clarksville, Tenn., under A. C. Morgan, of the Bureau of Entomology.

A short course in Apiculture was given at the Ontario Agricultural College at Guelph, Ontario, January 11–22, 1916, for the sixth year. A summer school was also held from June 12–16.

Mr. A. W. J. Pomeroy, who is now a captain in the third Nigerian Regiment, is in this country for a short time on leave. He is to return to active service in British West Africa on July 26.

Mr. W. S. Fisher, Bureau of Entomology, spent most of the month of June in the vicinity of Harrisburg, Pa., in continuation of his researches on the seasonal history of the hickory-bark beetle.

Miss Cora H. Clarke, of Boston, a collector and student of insect galls, died April 2, 1916, at the age of sixty-five years. Miss Clarke has published several papers on insect galls and caddis-flies.

The station of the Bureau of Entomology formerly maintained at Elk Point, S. D., has been transferred and the present address of this station is 5205 Morningside Avenue, Sioux City, Iowa.

Mr. J. N. Knull, a graduate of Pennsylvania State College, was appointed May 1 as temporary field assistant of the Bureau of Entomology and assigned to assist Mr. Craighead at East Falls Church, Va.

Mr. N. F. Howard, Bureau of Entomology, will be engaged in the same line of investigations as last year with headquarters at Madison, Wis.; his former station at Green Bay will be retained as a sub-station.

Dr. A. L. Quaintance, Bureau of Entomology, recently visited laboratories of the Bureau at Monticello and Orlando, Fla., as well as other points in Florida and Georgia, making observations on deciduous fruit insects.

Mr. C. H. Popenoe, Bureau of Entomology, has returned from his tour of inspection in the states in which investigations are being carried on regarding the status and control of insects as carriers of cucumber diseases.

The new department of forest zoölogy has been established in the College of Forestry at Syracuse University, and Dr. Charles C. Adams has been promoted to a full professorship and will have charge of this department.

Mr. Irving L. Bailey, Bureau of Entomology, formerly connected with the gipsy-moth force, has been transferred to the Federal Horticultural Board to assist in the supervision of the disinfection of imported cotton at Boston.

Dr. N. E. McIndoo, Bureau of Entomology, spent about two weeks at Winchester, Va., making observations on the effect on bees of spraying orchards. He also spent some time in the general vicinity of Fennville, Mich., in similar work.

Mr. R. I. Smith, who is in charge of the Federal Horticultural Board's office in Boston, reports that since March 10, 1916, something over 65,000,000 pounds of cotton have been disinfected by the two fumigation companies in that city.

Mr. F. E. Brooks, Bureau of Entomology, engaged in fruit-tree borer investigations, with headquarters at French Creek, W. Va., spent some time visiting apple orchards in the Northern States, making observations on fruit-tree borers.

Dr. W. D. Hunter visited the laboratories at New Orleans, Mound, Tallulah, and Dallas during June. With Dr. Howard he attended the annual field meeting of the Louisiana Sugar Planters' Association at New Orleans on June 8.

Mr. A. G. Davis, a student of Tulane University, has been appointed a temporary field assistant in the Bureau of Entomology for service in connection with the shipment of parasites of the sugar-cane borer from Cuba to the laboratory at New Orleans.

Mr. Edward P. Van Duzee, instructor in Entomology at the University of California at Berkeley, has resigned to accept the position of Curator of the Department of Entomology of the California Academy of Sciences, Golden Gate Park, San Francisco, Cal.

Mr. H. K. Laramore, a graduate of Purdue University, formerly field assistant at Knox, Ind., where he was engaged in investigation on the cotton thrips, will take charge of the pickle-disease insect-problem station of the Bureau of Entomology at Plymouth, Ind.

Mr. R. A. Cushman, Bureau of Entomology, engaged in investigations of parasites of deciduous fruit insects, has returned to his field headquarters at North East, Pa., where he will continue his studies of Hymenopterous parasites of the grape-berry moth and other insects.

Mr. R. N. Wilson, Bureau of Entomology, reports that experiments relating to *Laphygma frugiperda* carried on in Florida and Georgia during the past winter indicate that the insect did not succeed in surviving the winter much north of the latitude of Gainesville, Fla.

Mr. F. X. Williams, Bureau of Entomology, who has been employed on the Gipsy Moth Work, has accepted a position with the Hawaiian Sugar Planters' Experiment Station. He will proceed to the Philippine Islands and assist in collecting parasites for introduction to Hawaii.

Mr. D. G. Tower, Bureau of Entomology, who was detailed for seven weeks to assist in the fumigation of cotton in Boston, returned to Washington, and is now temporarily located in Newark, N. J., supervising the fumigation of cotton at the plant recently erected by the Clark Thread Company.

Dr. A. L. Quaintance, Bureau of Entomology, recently visited Sandusky, Ohio, where a conference was held with Prof. H. A. Gossard and W. H. Goodwin, of the Ohio Agricultural Experiment Station, and Messrs. Dwight Isely and H. G. Ingerson, of this Bureau, in connection with inauguration of grape-berry moth investigations in Northern Ohio.

Plans are under way by the Bureau of Entomology for beginning demonstration work in beekeeping during the next fiscal year. The work will be inaugurated in certain Southern States, including North Carolina, where E. G. Carr made a preliminary survey last autumn. The work will be conducted in coöperation with the States Relations Service.

Dr. R. R. Parker, of the Massachusetts Agricultural College, was recently appointed a scientific assistant in the Bureau of Entomology but was forced to decline on account of reasons connected with his family. Dr. Parker has specialized in the *Sarcophagidæ* and during the summer of 1914 and 1915 was in the employ of the

Montana Board of Entomology. He has recently published several important papers.

The heavy packing used in the wintering of the colonies in the Drummond apiary of the Bureau of Entomology proved quite beneficial, the only colonies lost during the winter being those which were so weak in the fall as to make wintering virtually impossible.

Mr. F. M. Wadley, a senior at the Kansas State Agricultural College, and formerly field assistant in the Bureau of Entomology in investigations under the direction of F. B. Milliken, at Wichita, Kan., has been reëngaged to assist in the same work for the present season.

Mr. A. T. Speare is very anxious to obtain scale insects of the genus Lecanium, or its near relatives, that are parasitized by fungi, and specimens of these insects from any host plant will be gratefully received. (Address: A. T. Speare, Bureau of Entomology, Washington, D. C.)

Mr. S. A. Rohwer, of the Bureau of Entomology, is anxious to get *Cimbex* larvæ. He wants live material of large larvæ with host, locality, and other data. They should be sent to him in tin boxes stocked with food and addressed to East Falls Church, Va., Forest Insect Field Station.

Mr. R. E. Campbell, Bureau of Entomology, who has been in charge of an experiment station at Hayward, Cal., will remove to Pasadena, Cal., as new headquarters, retaining Hayward as a sub-station. He will continue work on insects injurious to stored products, to sugar beets, and to truck crops.

Mr. H. E. Smith, Bureau of Entomology, reports that an inspection of the region in the Merrimac Valley of New England which was heavily infested with grasshoppers and treated with poisoned baits last summer, reveals the fact that very few grasshopper eggs are to be found alive this spring.

According to *Science*, Dr. Frank E. Lutz, of the American Museum of Natural History, New York, and Mr. J. A. G. Rehn, of the Academy of Natural Sciences, Philadelphia, have planned to spend July and part of August making a field study of the insect fauna of the isolated mountains southwest of Tucson, Ariz.

Mr. Raphael Zon, Chief of Forest Investigations, of the Forest Service, spent several days during the latter part of May inspecting the silvicultural experiments and conferring in regard to the coöperative work which is being carried on by the Bureau of Entomology and the Forest Service in connection with the gipsy moth problem.

An extension project has been started by the Bureau of Entomology in coöperation with the South Carolina Agricultural College. The object of the work is to place the results of the recent investigations of the cotton wireworm in the possession of planters throughout the state. This is the first project of this kind which has been organized in the Bureau.

At the invitation of Mrs. John Dickson Sherman, Chairman of Conservation of the General Federation of Women's Clubs, the branch of Forest Insect Investigations of the Bureau of Entomology coöperated in an exhibit under the auspices of the Federation in the 7th Regiment Armory, New York City, held May 23 to June 1. The exhibit consisted of specimens of the work and insects of the hickory barkbeetle, *Scolytus quadrispinosus* in hickory, and the two-lined chestnut borer, *Agrilus bilineatus* affecting oak. Placards, with specimens of work of the two insects and folders

giving illustrations of the character of the insects' work and describing causes and remedies and calling special attention to the importance of community effort in control operations, were also on exhibition and for distribution.

According to *Science*, Chicago University on its twenty-fifth anniversary conferred the honorary degree of Doctor of Science on Professor William Morton Wheeler, dean of the faculty of the Bussey Institution of Harvard University.

Mr. H. L. Sanford, Bureau of Entomology, recently collected what appears to be a new and undescribed species of *Aonida* on condurango pods from Ecuador. On April 1 he also intercepted *Parlatoria chinensis* on peach from Northern China. This scale insect is a common and widespread species in Northern China and represents a very undesirable importation.

Mr. W. W. Yothers, Bureau of Entomology, in company with Messrs. W. J. Krome and L. S. Tenny, members of the Florida Plant Board, left Orlando on June 19 for a brief trip to Cuba to study the various insects infesting citrus on this Island. En route Mr. Yothers will stop off at various points on the Florida Keys to further investigate insects infesting limes.

Dr. Paul Marchal has prepared a book which will soon appear giving an account of his visit to America. The title, translated, is "The Biological Sciences Applied to Agriculture and the Struggle against the Enemies of Plants in the United States." The volume will cover about 400 royal octavo pages, and is enthusiastic in its praise of the organization of the Bureau of Entomology.

Mr. C. H. Popenoe, Bureau of Entomology, will visit the stations which have been established, in coöperation with the Bureau of Plant Industry, for investigation of insects as carriers of mosaic, wilt, and other diseases of cucumbers and other cucurbits in the states of Wisconsin, Michigan, and Indiana. He will supervise the preparation of experimental plats with reference to the control of these insects and for community demonstration experiments.

Messrs. A. F. Burgess, D. M. Rogers, and L. H. Worthley were in Washington during May to attend the hearing before the Horticultural Board on the quarantines of the gipsy and brown-tail moths. It was decided by the Board that the present provision under which Christmas trees and greens are shipped from the infested territory under inspection will be continued. It was also decided that notices of all shipments which are inspected under the quarantines will be sent to the officials in the states to which they are forwarded.

The beet or spinach leaf-minor (*Pegomya vicina* Lint.) has been reported injurious in various sections of New York, and especially on Long Island, to table beet and Swiss chard, the latter being a new food plant. Agents and correspondents will assist in investigations of this insect if they will kindly send leaves of sugar beet, table beet, spinach, and chard, infested by this insect for possible rearing of parasites. Nicotine sulphate and other reagents should be tested as repellents or deterrents to protect against the adult or fly depositing her eggs on the leafage.

According to *Canadian Entomologist*, Dr. Alfred E. Cameron has been appointed a field officer of the Entomological Branch, Ottawa, Canada, and will be specially charged with the investigation of the pear thrips and other insects in British Columbia. Dr. Cameron graduated from the University of Aberdeen in 1909, received the degree of Master of Science from the University of Manchester in 1912, and after holding a Government Scholarship and conducting investigations in England and the

United States, he received the degree of Doctor of Science in 1915 from Aberdeen University. In 1914 Dr. Cameron conducted practical spraying experiments at the New Jersey Agricultural Experiment Station under Dr. Headlee.

Mr. D. J. Caffrey, of the Maxwell, N. Mex., station of the Bureau of Entomology, reports an unusual scarcity of the larvæ of *Hemileuca* this season. A long period of drought has apparently resulted in the prevention of the hatching of the eggs of the range caterpillar. Mr. Caffrey is having great difficulty in securing enough caterpillars to furnish food for rearings of the predaceous enemies of the range caterpillar. The heads of field stations of the Bureau are therefore asked to send to Mr. Caffrey lepidopterous larvæ of any kind which may be used as food for Calosoma beetles or as hosts for the Tachinid fly, *Compsilura concinnata*. These larvæ should be packed in such a way as to reach Mr. Caffrey alive and in as good condition as possible.

Mr. T. E. Snyder, Bureau of Entomology, left Washington on May 9 to investigate the character and extent of damage to "Australian pine" trees, *Casuarina equisetifolia* in southern Florida, by a buprestid beetle, *Chrysobothris impressa* Fab., an insect presumably introduced into this country. According to W. S. Fisher the species occurs in Dutch Guiana, Santo Domingo, and probably in Cuba. The Australian pine, a rapid-growing, graceful tree, is planted in large numbers in southern Florida in groves along roadsides and land developed along the seacoast. This buprestid breeds in the native red mangrove tree in nearby swamps, and had previously been collected at Key West by E. A. Schwarz. The larvæ of the beetle girdle the cambium of the young Australian pine trees and badly disfigure, greatly weaken, or kill the trees.

According to *Science*, The California State Board of Health, in coöperation with the University of California, is conducting a state-wide malaria mosquito survey under the supervision of Professor W. B. Herms, consulting parasitologist for the state board and associate professor of parasitology in the University of California, who is assisted by Mr. S. B. Freeborn, instructor in entomology. The work began on May 10 and will continue through the summer. Probably three summers will be required to complete the survey of the entire state. The party travels by automobile, collecting mosquitoes, locating their breeding places, determining the presence or absence of malaria, distributing literature, lecturing and giving information on ways and means for the control of the insects. The Sacramento Valley and the northeastern portions of the state to the Oregon and Nevada state lines have already been covered. Thus far endemic malaria has been found at a maximum elevation of 5,500 feet and the Anopheline carriers have been located. Two or three new species of mosquitoes have been found.

Insects as Food for Man. Now that the season of insect activity is on again, attention of field workers is called to the desirability of experiments on the edibility of insects. Recently *Lachnosterna* larvæ have been made into a salad by Dr. Langworthy of the Office of Home Economics, and this salad has been tasted by about a dozen men in the Bureau, who found it not at all disagreeable. A broth was also made, which Mr. O'Leary and the writer found very good. Mr. Craighead told me yesterday that he had been trying Cerambycid larvæ fried in butter, and, while he is not enthusiastic, he pronounces them edible. I will make no suggestions as to method of preparation, but will leave that to the ingenuity of any who have a chance to experiment.

L. O. Howard

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Proceedings of the First Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The first annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in the library of the San Diego High School, San Diego, Cal., August 10 and 11, 1916.

Because of the isolation of the place there was not a large attendance, but the meetings were interesting and profitable.

The business was interspersed with the papers, the proceedings occupying the afternoon of August 10 and the forenoon of August 11.

Because of the absence of Dr. E. D. Ball, Chairman, the meetings were called to order at 2.30 o'clock p. m., August 10 by the secretary, who explained the formation of the Pacific Branch and the discontinuation of the Pacific Slope Association of Economic Entomologists. A number of members of this latter organization who presented applications to join the branch were present and took part on the program.

The first matter placed before the convention was the election of a chairman. Prof. H. J. Quayle was elected and presided over the meetings.

During both sessions twenty-one members and visitors were present.

The following members were in attendance:

D. L. Crawford, Claremont, Cal.
E. O. Essig, Berkeley, Cal.
H. J. Quayle, Riverside, Cal.
L. P. Rockwood, Forest Grove, Ore.
H. S. Smith, Sacramento, Cal.
E. G. Titus, Logan, Utah.

Upon a motion of the house which was duly seconded and carried the chairman appointed the following nomination committee: E. G. Titus, Chairman, H. S. Smith.

The regular program of the day was then taken up.

CHAIRMAN H. J. QUAYLE: The first paper on the program by W. M. Davidson will be read by the secretary.

ECONOMIC SYRPHIDÆ IN CALIFORNIA[1]

By W. M. Davidson, *Scientific Assistant*, U. S. Bureau of Entomology, Deciduous Fruit Insect Investigations

The *Syrphidæ* have long been looked upon as an important factor in the control of plant-lice and other homopterous insects, and although there are a few species injurious to cultivated plants our present knowledge plainly indicates that the balance is very heavy on the beneficial side.

California is rich in beneficial species, the majority of which belong to the tribe *Syrphini* which is centered around the type genus *Syrphus*. These species prey almost exclusively on plant-lice, the species *Baccha lemur* Osten Sacken attacking mealy-bugs (*Pseudococcus*) and *Sphærophoria sulphuripes* Thomson being predaceous on the Bean Thrips (*Heliothrips fasciatus* Perg.) in southern California.

Just as we have imported from Europe many injurious aphidids, *e. g.*, *Aphis pomi* DeGeer, on apple, pear, loquat; *Hyalopterus arundinis* Fabr., on prune and plum; *Aphis rumicis* L., on bean; *Aphis medicaginis* Koch on leguminous crops; *Macrosiphum pisi* Kalt., on peas; *Aphis brassicæ* L., on cruciferous crops; *Chromaphis juglandicola* Kalt., on walnuts, so there have come to us some of their syrphid enemies. By far the most important of these is *Catabomba pyrastri* L. This species finds a home throughout California and in certain years becomes extremely abundant wherever severe aphidid infestations occur in orchard or field. Two such years in central California were 1912 and 1914. The adult fly is easily recognizable by its large size and by the three pairs of lunate whitish-yellow spots on the abdominal disc. A melanoid variety of the female (*unicolor*) is spotless and this form is rare except in years when the species is especially abundant. In 1914 the variety was very abundant while in 1913 and 1915 very few could be observed. The pale green, white-striped larvæ are voracious feeders. They may consume a thousand plant-lice of average size in the course of their two or three weeks' larval existence. They appear first early in March and thus have a start of the lady-bird beetles and other predators which do not appear much before April. About the first of March the adult flies begin ovipositing among colonies of winter-feeding plant-lice such as *Macrosiphum rosæ* L. on roses and *Macrosiphum solanifolii* Ashm. on weeds such as filaree (*Erodium*) and toward the end of the month eggs are placed among young colonies of orchard aphidids the stem-mothers of which hatched from the winter eggs in February and early March. It is not common

[1] Published with the permission of the Chief of the Bureau of Entomology.

to find this latter type of aphidids attacked before they have secured a good start, a phenomenon which suggests a balance of nature which strives to provide enough food for future generations of syrphids by guarding against the wholesale destruction of the young stem-mothers. If the adult flies that issue early in spring confined their attention to the young stem-mothers of the orchard aphidids, the latter would be either wiped out or so restricted that there would not be food for the future generations of flies.

Throughout summer and fall the larvæ of *Catabomba pyrastri* attack all varieties of injurious aphidids that they can reach. The species must be credited with enormous destruction among plant-lice. All things considered it is one of the most beneficial insects in California, vieing with such well-known species as the Vedalia (*Novius cardinalis*), the Chalcidine scale parasites, and *Hippodamia convergens*.

In California there are about 14 species of *Syrphus*, 9 of which are either quite uncommon or confined to mountain districts. However *S. ribesii* L., *S. torvus* Osten Sacken, *S. americanus* Wied., *S. opinator* Will., and *S. arcuatus* Fallen attack injurious plant-lice in appreciable numbers. Very beneficial are the two most abundant of them, *S. americanus* and *S. opinator* whose larvæ are general feeders and may be taken frequently among colonies on cultivated plants. The larvæ of *S. arcuatus* occur in early spring on coniferous plants feeding upon aphidids occurring thereon and later they attack principally such semi-protected species as *Aphis malifoliæ* Fitch on apple. Like *torvus* and *ribesii*, *arcuatus* is common to Europe and North America. All the members of the genus in California have yellow or reddish-yellow transverse bands on the abdomen. In *arcuatus* the three principal bands are interrupted, while in the others above mentioned only the first band is interrupted. The larvæ are brown, yellow or purple and the puparia brown. The larvæ are not so large or voracious as those of *Catabomba pyrastri*. Closely allied to *Syrphus* is a common species, *Eupeodes volucris* Osten Sacken. This fly is marked like the members of the genus *Syrphus* but is somewhat smaller, albeit large examples of the female are almost indistinguishable from the female of *Syrphus arcuatus*. The larvæ have been bred from injurious and other plant-lice.

The genus *Sphærophoria* is represented in California by three species, *Sph. melanosa* Will., *Sph. sulphuripes* Thomson and *Sph. micrura* Osten Sacken, of which the two first at least are aphidophagous in the larval stage. These are common flies, narrow-bodied and small, and are peculiar in having extra segments to the abdomen. They are blackish with bright yellow cross-bands. The larvæ and puparia are green and the pupæ commonly occur on the plant on which the larvæ

have been dwelling, in this respect differing from the species previously discussed in which the larvæ pupate in loose soil or rubbish at the base of the plant. The larvæ of *Sphærophoria sulphuripes* also prey upon the Bean Thrips (Russell, The Bean Thrips, U. S. D. A., Bul. 118, 1912).

Allograpta obliqua Say is a well known enemy in southern California of the citrus and truck crop plant-lice. Further north the fly is less common and it has been bred from the walnut aphis (*Chromaphis juglandicola* Kalt.). *A. fracta*, a rarer species, is presumably aphidophagous. The adult flies are rather small. They have yellow cross-bands and in addition longitudinal and oblique yellow markings on the fourth and fifth segments.

In the allied genus *Mesograpta* there are two common California species, *M. geminata* Say and *M. marginata* Say. These are small species, shining black with yellowish-red abdominal markings. Their economic standing appears to be unknown while the eastern *M. polita* Say is an injurious form, attacking corn plants and sometimes causing them to wither badly.

Baccha is a genus of slender elongate flies, in which the body is more or less constricted basally. The larvæ of *B. lemur* Osten Sacken have been bred from the citrus mealy-bug (*Pseudococcus citri* Risso) ("Mealy-Bugs of Citrus Trees," Univ. Cal.; Coll. Agric. Bul. 258, C. P. Clausen) and other mealy-bugs (Cal. State Comm. Hort. Mo. Bul., vol. IV, 4, E. O. Essig) in southern California where the species is common. The larval habits of *B. obscuricornis* Lœw (? *B. elongata*), found about San Francisco Bay are unknown. Elsewhere other species of *Baccha* have been reported (*e. g.*, "Syrphidæ of Ohio," Ohio State Univ. Bul. XVII, 31, C. L. Metcalf) as preying in the larval stage upon aphidids, coccids, leaf-hoppers and white-flies.

The two aphidophagous genera *Pipiza* and *Paragus* belong to the tribe *Chilosini*, a group in which the larvæ chiefly inhabit stems and stalks of hollow plants. *Pipiza pisticoides* Will. and *P. albipilosa* Will. are rather small, black, shining species and bear much short white pile. They are both common in California and their larvæ feed on protected or semi-protected plant-lice such as *Pemphigus populicaulis* Fitch on poplar. It is doubtful whether these are of much economic importance but further study might alter this opinion, as both *P. modesta* Lœw and *P. radicum* Walsh & Riley occur in the East upon the woolly apple aphidid (*Eriosoma lanigerum* Haus.) and *radicum* preys also upon the grape phylloxera (*Phylloxera vitifoliæ* Fitch). *Pipizæ* larvæ in California are dark green or greenish-brown and the puparia brown. Both larvæ and pupæ are somewhat more robust and roughened than those of the *Syrphini*.

Paragus tibialis Fallen and *P. obscurus* Meigen, whether considered as two valid species or as two varieties of a single species, are common flies. The adults are small shining black or reddish-black flies. The larvæ are aphidophagous; that of *tibialis*, according to Metcalf (Ohio State Univ. Bul. XVII, 31) is light yellowish-brown. The small size of these species rather militates against their economic importance. The larvæ feed on aphidids attacking such semi-aquatic plants as dock.

Of all these species mentioned above the most important economically are in order probably *Catabomba pyrastri*, *Syrphus opinator*, *S. americanus*, *S. arcuatus*, *Allograpta obliqua*, and *Eupeodes volucris*. The first named probably outweighs all the others together.

In California syrphid larvæ are frequently the victims of Ichneumonid parasites belonging to the genera *Bassus*, *Syrphoctonus*, *Homotropus* and perhaps others. They are also parasitized by Chalcids. At times large numbers of the adults are destroyed by fungi, one such outbreak being noticeable in the spring of 1914, in central California.

Two injurious species of *Syrphidæ* have recently been found in California and both are importations from Europe. The Narcissus bulb-fly (*Merodon equestris* Fabr.) is apparently now established in central California and *Eumerus strigatus* Fallen, said to be injurious to onion bulbs in Europe, has apparently become established in the San Francisco Bay region. Both of these species have been taken on the wing on several occasions. Their larvæ dwell inside the bulbs and may cause their destruction. *Merodon equestris* is a large hairy robust fly somewhat resembling a bumblebee while *Eumerus strigatus* is a small, black shining, almost bare, species. *Copestylum marginatum* Say and species of *Volucella* in their larval stages inhabit the interior of cactus leaves and stems and may cause injury to the host (Cf. "Principal Cactus Insects of United States," W. D. Hunter, F. C. Pratt, J. D. Mitchell, U. S. D. A., Bul. 113, 1912).

Chairman H. J. Quayle: This paper is now open to discussion.

Secretary: The following communication from H. E. Burke regarding this paper has been received and is as follows:

"I would be glad to be there at the discussion of Mr. Davidson's paper to call attention to the damage done by the larvæ of some forest *Syrphidæ* to our timber. The larvæ (bark maggots) of *Cheilosia* and probably other genera cause serious defects (black checks) in the wood of much of our white fir (*Abies concolor*), red fir (*Abies magnifica*) and hemlock (*Tsuga heterophylla*). In most discussions of the *Syrphidæ* the injurious habits are not given."

Chairman H. J. Quayle: The next paper by G. F. Moznette will be read by the secretary.

THE FRUIT-TREE LEAF SYNETA, SPRAYING DATA AND BIOLOGICAL NOTES[1]

By G. F. Moznette

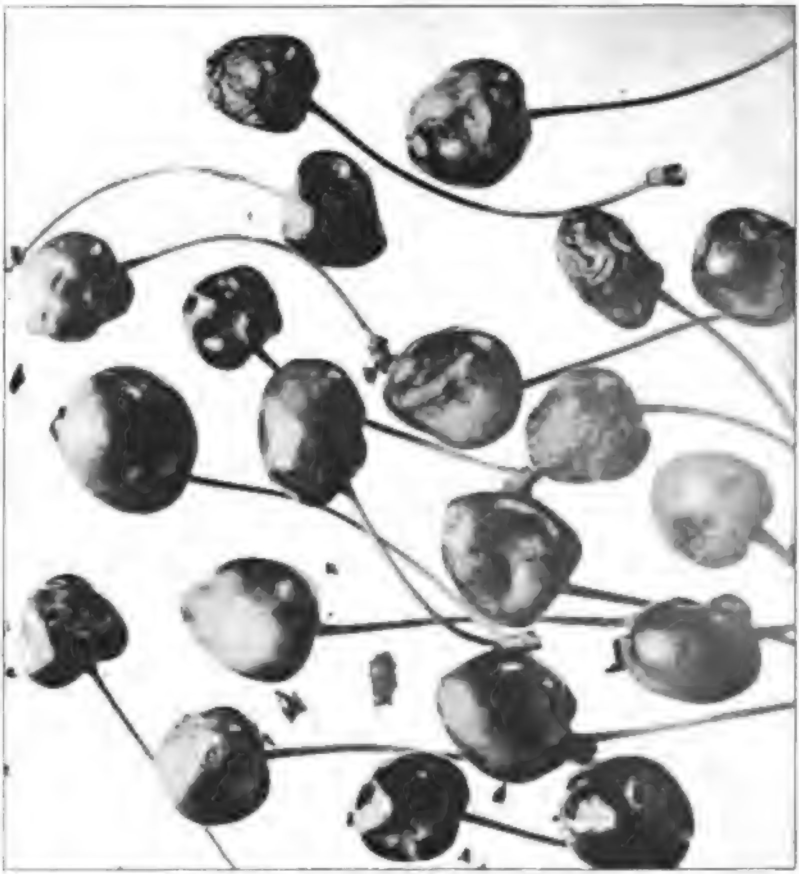
During the past spring the prune and cherry growers of the Willamette Valley in Oregon had considerable loss due to the ravages of the Fruit-Tree Leaf Syneta, *Syneta albida* Lec. The species is a member of the family *Chrysomelidæ* and is primarily a leaf feeder. However, at the time this species is particularly abundant, the young developing fruit of the cherry and prune is severely attacked. The injury which consists of a pitting to the fruit causes it to be scarred or blemished so badly that it is rendered unmarketable, and it may also ripen prematurely and fall (Pl. 31, fig. 1). In many cases the stems are also badly nibbled (Pl. 32, fig. 2). In the case of the cherry and prune particularly, the beetles seem to prefer the tender fruit to the leaves and petals (Pl. 33, fig. 3); these, however, are often eaten severely and cause considerable alarm. Fortunately the species in puncturing the petals, an injury which is often very conspicuous, does not injure the fruit-forming parts of the flower (Pl. 33, figs. 3, 4). Considerable injury is also caused to the foliage of young trees, and often means the death of the grafts when the individuals are abundant.

Investigation into the distribution of this species shows it to be confined to the Pacific Coast. The species is found from Western British Columbia south to Alameda county on San Francisco Bay. Upon examination of specimens in the writer's collection individuals are recorded as collected from Contra Costa County, Oakland and Nashmine in California by Dr. E. C. Van Dyke. Other specimens were taken at Seattle, Port Angeles and Monroe in Washington. It is fairly well distributed over the entire Willamette Valley, Oregon, particularly in the northern part. Specimens collected in British Columbia were taken at Vernon. The species was not known to exist east of the Cascade Mountains but recently a report was noticed in which Mr. M. A. Yothers[2] reports it as being a serious pest to apple at Walla Walla, Washington. He also reports it from Payallup, Washington, near Seattle.

Upon examination the species was found to be exceedingly variable in coloration, apparently according to its typographical distribution. The male possesses subacute angulations at the sides of the thorax without denticulations. The costæ in this species are very variable

[1] Contribution from the Entomology Department of the Oregon Agricultural College.

[2] Bul. No. 124, Bud Weevils and Other Bud-eating Insects of Washington, by M. A. Yothers, Pullman, Wash.



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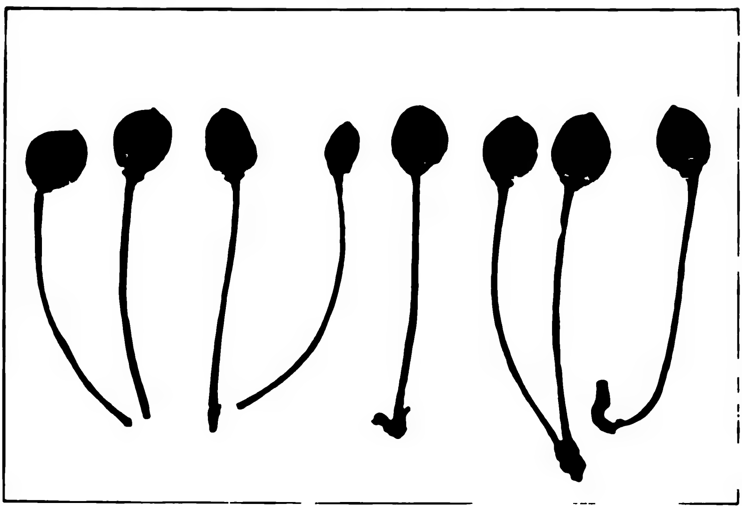

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and may be entirely absent. The color is usually a grayish-white to testaceous with the suture nearly black. The posterior tibiæ are simple with terminal spurs. The female is usually a yellowish-white and varies less in color than the male. The forms recorded from Nash-mine in Trinity County, California, at an elevation of 5,000 feet, are much larger than are any of the individuals collected at other points in California and at points to the north. The species has not been found south of San Francisco Bay, occasionally one may be found in the hills near Oakland, California. In that region it is often confused with a variety of an allied species, *Syneta simplex* Lec., which is usually the most destructive to fruits in sections of California,[1] and occurs in greater abundance than does *Syneta albida* Lec. Specimens recorded from Port Angeles, Washington, are very dark in appearance, the dark brown approaching a black. A specimen taken at Yaquina Bay in Oregon is a deep red in color. The striations on the elytra of both sexes, which is a characteristic distinguishing it from the existing species, vary greatly according to the locality in which they are found. A more detailed account of the variations of this species is intended to be incorporated in a later paper on the revision of the genus *Syneta*.

The original host of this species is not known to the writer. In many instances the beetles were found working on vine maple and hazelnut trees which may possibly be their native hosts. Among the fruit trees which are attacked may be listed the apple, cherry, prune, pear, quince, plum and wild crabapple. Occasionally the small fruits, as currant and gooseberry, are attacked.

Due to the fact that considerable alarm existed among the orchardists of the Willamette Valley, a series of spraying experiments were conducted in a preliminary manner to test the efficiency of a few sprays as killing agents or as repellents. At the time when this insect is doing its destructive work the precipitation in western Oregon is very heavy. This is during April and May. Hence it is absolutely essential that the spray materials possess adhesive and colloidal properties. This year the adults were particularly numerous from the last of April until the last of May.

In the experiments conducted the sprays were applied after the beetles had already done some damage, but as the beetles are capable of living from a month to six weeks fairly good data could be obtained from the action of the sprays used under our climatic conditions. The following applications were applied to Italian prunes on the place of Mr. C. O. Constable at Salem, Oregon, in May, a short while after the petals had fallen or just after the shucks had fallen: Black Leaf 40

[1] Injurious and Beneficial Insects of California, E. O. Essig, Cal. State Com. of Horticulture, Sacramento, Cal.

at the rate of 1–400 plus lime-sulphur 1–35, fifty trees sprayed; white hellebore 2 lbs. to 50 gallons of lime-sulphur 1–35, fifty trees sprayed; triplumbic arsenate of lead, 3 lbs. to 50 gallons of lime-sulphur 1–35, sprayed 100 trees. The rest of the orchard was sprayed with regular neutral lead arsenate 2 lbs. to 50 gallons of lime-sulphur 1–35. A few cherry trees were also sprayed with this material to test for burning properties as well.

The results of these preliminary experiments showed that due to our excessive rains at intervals the Black Leaf 40 and white hellebore, when used with lime-sulphur, cannot be relied upon as they are subject to being washed away. A short while after the trees were sprayed the foliage upon examination was very badly eaten into and many of the small fruits pitted. In check experiments carried on at Corvallis where the beetles were confined in cheesecloth bags over apple trees, it was found that the beetles did not seem to mind the Black Leaf 40 and white hellebore when used alone and ate very voraciously of the foliage. At Salem, Oregon, it was observed that the regular arsenate of lead when applied in greater strengths than 2 lbs. to 50 gallons of lime-sulphur 1–35 cannot be used with safety on the tender cherry foliage. The triplumbic arsenate of lead gave very good results and may be used in greater strengths than the regular neutral arsenate of lead on cherry and prune foliage. The Italian prune trees where the arsenate of lead was used were less riddled, the prunes were cleaner from pitting and occasionally one or two beetles could be shaken from the trees. The arsenate of lead, both triplumbic and the regular neutral, showed very good adhesive properties when used with lime-sulphur and the foliage was well coated two weeks after the applications in spite of our excessive hard spring rains. It is possible that the triplumbic arsenate of lead may be used at greater strengths than was used with good results on the foliage of cherry and prune.

In this state where the brown rot of stone fruits, *Sclerotina fructigena*, is prevalent and spraying operations must be conducted against it in the case of cherries and Italian prunes and plums, combination spraying should be practiced more extensively, in those sections where the two evils exist.

In the case of prunes, plums and cherries which are sprayed for brown rot just after the blossoms open with Bordeaux Mixture 4–4–50 or lime-sulphur 1–35, arsenate of lead should be added 3 lbs. to 50 gallons of the spray, and preferably the triplumbic arsenate of lead as the foliage of cherry particularly is very susceptible to arsenic injury. In the spray against brown rot and Coccomyes (Cylindrosporium), the leaf spot or shot hole to be applied 10 days or two weeks after the shucks fall, add arsenate of lead 3 lbs. to 50 gallons of the spray. At

this time Bordeaux is used at the rate of 4–4–50; and lime-sulphur at the rate of 1–50. In the case of the apple and pear, arsenate of lead may be added at the rate of 3 lbs. to 50 gallons of lime-sulphur in the "pink" for apple scab, *Venturia pomi*. The arsenate of lead incorporated against the codling moth will be sufficient in subsequent sprays for the apple and pear.

Explanation of Plates 32, 33

1. Cherries pitted and deformed by *Syneta albida* Lec.
2. Young cherries pitted and stems gnawed, adults.
3. Apple showing the characteristic work of the adults on foliage.
4. Injured and uninjured apple blossoms.

Chairman H. J. Quayle: The next paper will be by E. O. Essig on the chrysanthemum gall-fly.

THE CHRYSANTHEMUM GALL-FLY, DIARTHRONOMYIA HYPOGÆA (F. LÖW)

Cecidomyia hypogœa F. Löw, Verh. Zoöl.-Bot. Ges. Wien, XXXV, p. 488, 1885. (Figures 1-7)

By E. O. Essig, *Agricultural Experiment Station, Berkeley, California*

Though the chrysanthemum gall-fly has been known as a pest in Europe for many years it was not recorded as occurring in the United States until April 1915 when Dr. E. P. Felt received specimens from Prof. R. H. Pettit of Michigan.[1] In September of the same year Mr. C. C. Barnum, a student at the University of California, called attention to the work of a gall-fly on chrysanthemums growing in a greenhouse on the campus. From the infested plants the writer reared a large number of adults, some of which were forwarded to Dr. Felt who kindly determined them as the above and gave the published records of its previous occurrence in this country. Since that time the writer has made a general survey of the central part of the state and has found that the insect is quite abundant and destructive in the region of San Francisco Bay.

Description

The larvæ or maggots (Fig. 32 B) are very small, averaging only about 1.5 mm. in length and 0.8 mm. in diameter when full-grown. The shape is somewhat cylindrical with the anterior end more or less pointed and the posterior end broadly rounded. The color varies from transparent-white to pale yellow or orange.

[1] Jr. Econ. Ent. VIII, p. 267, April 1915.

The pupae (Fig. 32 C) are about the same size and shape as the larvae, but are slightly larger at the anterior end. The color is white or pale-yellow with amber

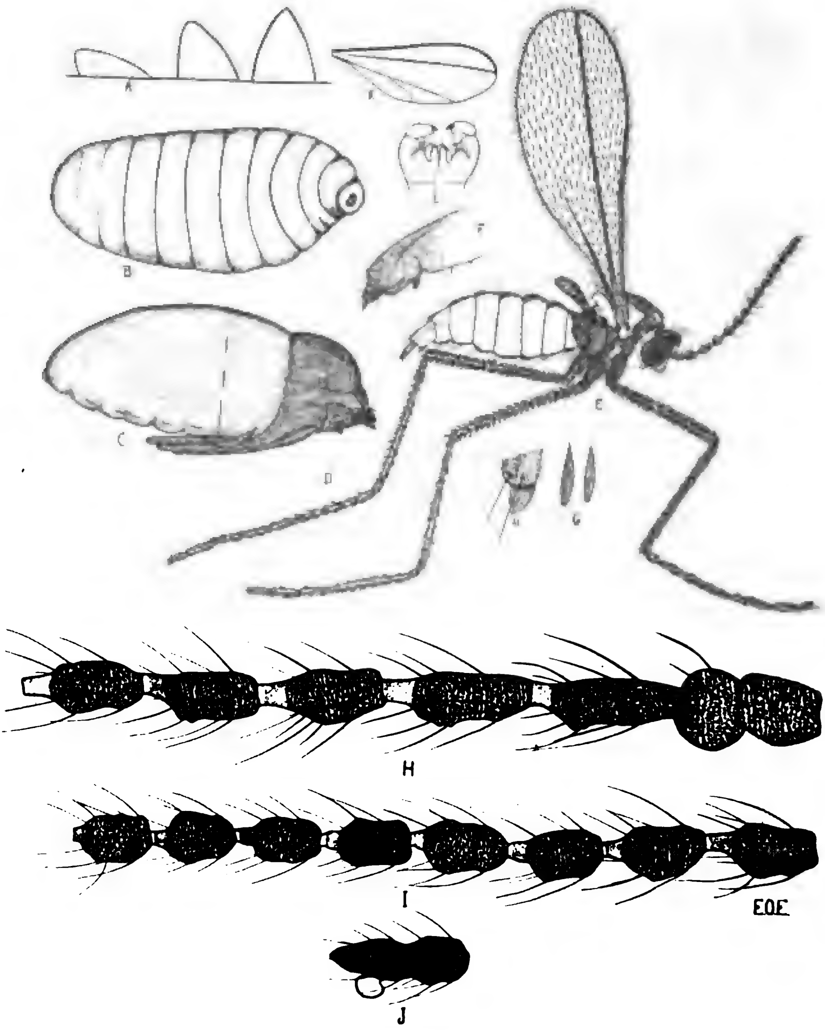

Fig. 32. The chrysanthemum gall-fly, *Diarthronomyia hypogæa* (F. Low). *A*, galls as they appear above the surface of the plant; *B*, larva; *C*, pupa; *D*, enlarged anterior projections of same; *E*, adult female; *F*, ovipositor of female; *G*, scales from legs; *H*, *I*, *J*, sections of the antenna; *K*, wing showing slight variations; *L*, genitalia of male; *M*, palpus. Enlarged. (Original).

markings on the anterior region. There are two pairs of prominent tooth-like projections at the head, the first pair being noticeably larger than the second. The color of these projections is somewhat darker than the surrounding tissues.

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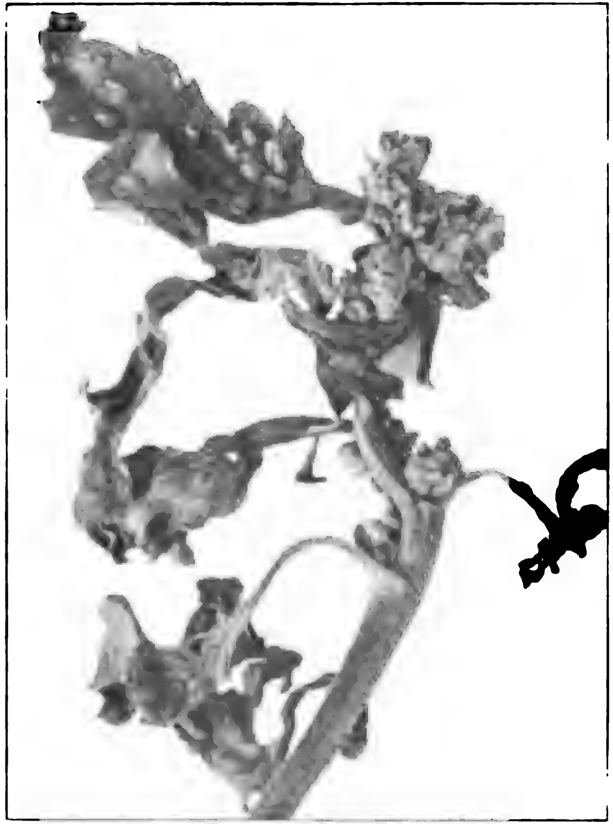

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The adults or flies (Fig. 32 E) are exceedingly delicate with noticeably long and slender legs. The head, antennæ, thorax and the base of the abdomen are dusky amber; the legs light-amber with light-colored femora; the abdomen bright or pale orange-red; and the eyes very dark-red. The wings are transparent or faintly smoky and covered with many scale-like hairs. The legs are also thickly beset with similar hairs or scales which are noticeably wider at the tip or somewhat spatulate-shaped (Fig. 32 G). The palpi (Fig. 32 M) are two-jointed and the antennæ (Fig. 32 H, I, J) are 16-jointed and normally hairy. The body is slender and averages 1.5 mm. in length.

Life-History

The habits of the insect have been under observation for only part of a year, but long enough to gain a fair idea of the main points in the life-history. During the summer months of August, September and October the maximum development is reached and there are great numbers of all stages after which there is a gradual reduction until the following spring and summer. The adults of the summer brood give rise to a very large number of maggots which hibernate in the galls on the leaves and stems of the plants. These reach maturity in the spring and give rise to the summer brood so that there appear to be but the two broods during a year. There is some overlapping of the broods since adults may issue as late as January and a few pupæ hibernate. The writer has been informed by florists, who have been acquainted with the habits of the insect for years, that the adults swarm in the greenhouses as early as five o'clock in the morning during the summer and that during the day they are not to be found. The former observation has not been substantiated, but the latter was carefully studied and it was found that though the adults could be found at all times during the day they were usually resting on the plants and seldom ever on the wing, though they were seen to fly freely at times but only when disturbed.

Nature of Work

As the common name implies, this insect produces galls which are very characteristic and may be found on the leaves, leaf-petioles, stems and buds of the food plants. The galls (Fig. 32 A, and pls. 34, 35, fig. 2–5) are decidedly cone-shaped and the main axis may be at right-angles or at an acute angle to the main axis of the leaves, stems and buds. Very often they may be almost wholly enclosed within the tissues so that only the tips are exposed. The greatest numbers are to be found on the tender shoots on both sides of the leaves, on the stems near the tips and on the buds. Infested shoots are often distorted beyond recognition (Pl. 35, figure 5) and are eventually killed. The color is first somewhat lighter than the surrounding tissues, but in time become bright red or brown. The size of the fully-developed

galls is quite uniform averaging about 3 mm. in length and 1 mm. in diameter at the base. They are most abundant during the fall and winter months. In many of the chrysanthemum growing districts in the San Francisco Bay Region as much as one third of the crop is annually lost unless preventive or control measures are adopted. Two florists at Alameda who at one time grew large numbers of cut flowers claim that the fly forced them out of business. Plants grown in greenhouses are injured most, but the attacks are also very severe in lath houses. Plants growing out-of-doors in the average house garden do not appear to become infested, at least a careful inspection has so far failed to discover such, and infested plants taken from a greenhouse or a lath house rapidly recover when placed outside where there is no protection from the elements. Last August the writer secured twenty-one infested plants from a greenhouse and set them in his garden. On all of the new growth which has appeared to date (February 24) there is not a single gall to be found, while checks left in the greenhouse and removed to a lath house are either still badly infested or are entirely ruined. It is perfectly possible however to conceive of a condition outside in a particularly protected and warm place where the insect may continue to breed.

Distribution

As previously stated the chrysanthemum gall-fly was first taken by the writer in California at Berkeley, though investigations show that it has been known to florists for over fifteen years in other places around San Francisco Bay. The writer has taken it in Alameda, San Francisco and San Mateo Counties. It probably occurs in the other counties which have not been visited. A single infested shoot of a chrysanthemum was received last fall from Mr. Arthur E. Beers, County Horticultural Commissioner, from Merced and it is not unlikely that the insect is distributed throughout the state where chrysanthemums are grown commercially.

Food Plants

The favorite food plant of this insect is the cultivated chrysanthemum, some strains of which are more susceptible to attack than others, but all appear to suffer to some extent at least. The ox-eye daisy (*Chrysanthemum leucanthemum*) is listed as a host in Europe.[1]

Control

The practice of growing the bulk of the chrysanthemum crop under cloth has been one of the chief means of preventing the attacks of the

[1] Kertész, C., Catalogus Dipterorum, II, p. 69, 1902.

chrysanthemum gall-fly and is by far the most efficient and satisfactory way of handling the situation. The young clean selected plants are propagated from the beginning in these insect-proof cloth houses and every precaution is taken to keep them clean and tight.

In greenhouses the difficulties are very great. Eliminating all infested plants and using only clean cuttings have given fairly good results, but means a continual fight from the very beginning to pre-

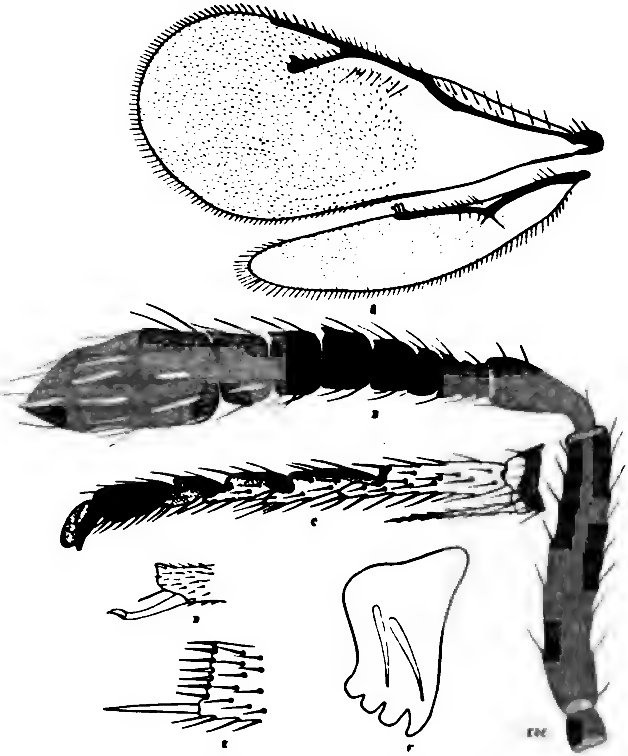

Fig. 33. Some detail anatomical characters of *Amblymerus* sp., a parasite of the chrysanthemum gall-fly. *A*, wings; *B*, antenna; *C*, middle tarsus; *D*, tibial spur on front leg; *E*, tibial spur on hind leg; *F*, mandible. Greatly enlarged. (Original).

vent reinfestation. Some florists take only underground cuttings from infested plants and get satisfactory results when all of the old plants are destroyed before the flies begin to emerge in the spring.

In lath houses there is continual danger of infestation which can hardly be avoided. One practice which works very well where the old plants are allowed to come up again during the winter and spring is to cut back the young shoots in November or December and again in February or March and burn the trimmings. In this way most of the

hibernating larvæ are destroyed and much of the crop may mature in good condition.

Nicotine sulphate or "Black Leaf 40" used in the proportions of 1 to 1600 of water will give temporary relief if applied once or twice, but to get good results it must be used every two or three weeks from June until just before blossoming time.

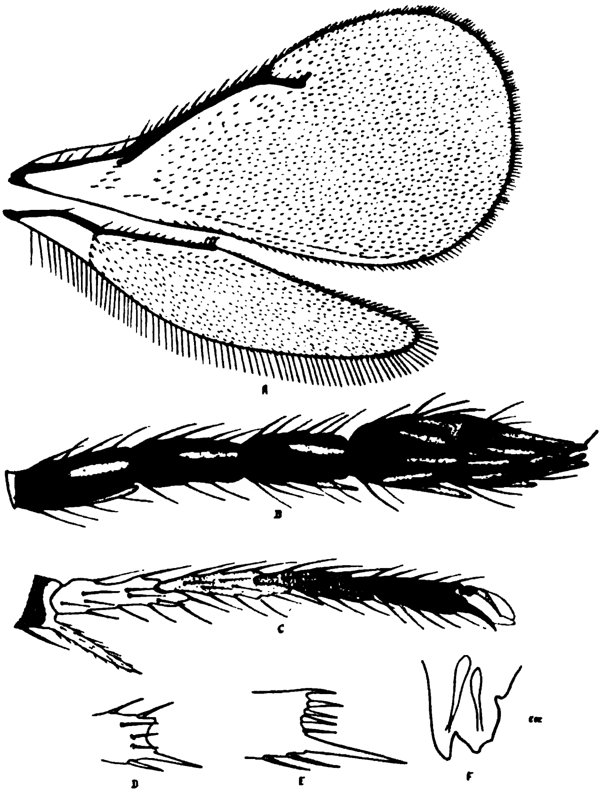

Fig. 34. *Tetrastichus* sp., a parasite of the chrysanthemum gall-fly. Detail drawings: *A*, wings; *B*, last five joints of the antenna; *C*, middle tarsus; *D*, tibial spur of front leg; *E*, tibial spur of the hind leg; *F*, mandible. Greatly enlarged. (Original).

Parasites

During the summer a large number of parasites were reared from infested plants and one species in particular did excellent work in the University greenhouse. The material was sent away for determination and a few observations made as follows:

Amblymerus sp. This hymenopterous parasite has been described by Mr. A. A. Girault, through the kindness of Dr. L. O. Howard, and

a description is to appear elsewhere. The adults are black with yellow markings on the legs. The females vary from 1 mm. to 1.2 mm. in length and the males are somewhat smaller. Some of the details in figure 33 will aid in distinguishing it. The larvæ live within the galls alongside the maggots of the gall-fly which they gradually consume. They remain within the galls until mature when they emerge through small circular holes. This species is the most abundant during the summer months and all of the adults were reared during August, September and October. In not a few cases as high as 80 per cent to 90 per cent of the maggots were destroyed.

Tetrastichus sp. (Fig. 34). The generic determination of this insect was made by Mr. Harry S. Smith, Superintendent of the State Insectary, Sacramento, California. It is also a small black parasite somewhat larger than the former and easily distinguished from it by the four-jointed tarsi and other characters shown in the accompanying drawings.

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[1] Since preparing this article some months ago the writer has received a copy of the 31st Report of the State Entomologist of the State of New York, June 1, 1916, from Dr. Felt and finds that the subject matter is much more thoroughly handled and that this paper would not be worth printing were it not for the local interest to California.

The above bibliography is taken entirely from Dr. Felt's paper with a rearrangement and a few minor changes.

Other localities given in Dr. Felt's paper are Oregon, and Ottawa, Canada, and the additional European host plants: *Chrysanthemum corymbosum*, *C. atratum*, *C. japonicum* and *C. myconis*. The varieties of *C. japonicum* are very generally infested in this district.

The technical description of the various stages is very complete in the above mentioned paper.

EXPLANATION OF PLATES 34, 35

Fig. 2. Chrysanthemum leaf showing newly formed galls of the chrysanthemum gall-fly on the under surface. Enlarged. (Original. Photo by Dept. Sci. Illust., U.C.).

Fig. 3. Stem of chrysanthemum showing the galls made by the chrysanthemum gall-fly. The round holes were made by parasites. Enlarged. (Original. Photo by Dept. Sci. Illust., U. C.).

Fig. 4. Tip of young chrysanthemum plant showing fully-developed galls of the chrysanthemum gall-fly. The galls were dark red and mostly on the upper surfaces of the leaves. (Original. Photo by Dept. Sci. Illust., U. C.).

Fig. 5. Young shoot of chrysanthemum plant showing the deformity due to the galls made by the chrysanthemum gall-fly. This is a fair example of the work in greenhouses and lath houses when control measures are not employed. Enlarged. (Original. Photo by Dept. Sci. Illust., U. C.).

CHAIRMAN H. J. QUALE: The next paper by Mr. E. Ralph de Ong on the Municipal Control of the Argentine Ant will be read by the secretary.

MUNICIPAL CONTROL OF THE ARGENTINE ANT

By E. RALPH DE ONG, *Instructor in Entomology, University of California*

The Argentine Ant was first recognized in California about 1908, at only eight points in the state but has since spread to most of the larger cities on the coast. The list of known infested towns in 1916 being as follows; San Diego, Corona, Riverside, Upland, Claremont, Azusa, Monrovia, Los Angeles, Montecito, Santa Barbara, Santa Maria, Salinas, San Jose, Cupertino, Saratoga, Redwood City, San Mateo, Burlingame, San Francisco, Alameda, Berkeley, Oakland, Piedmont, Stege, Martinez, Byron Hot Springs, Stockton, Sacramento, and St. Helena. In many of these towns the infested area is comparatively small but steadily increasing while in others, for instance Alameda, practically the entire town is infested.

Here is an example of a most annoying house pest spreading in a few years' time in scattering colonies over a strip of territory, 700 miles long, without any systematic effort being made to check its invasion. Carried from city to city by commerce they gain a foothold and slowly but surely spread out on every side in spite of the thousands of dollars spent by the householders and the hosts of ant remedies for sale; even a list of which is too cumbersome for this paper. Thirty-nine arsenical ant remedies have been recorded in this state alone, the percentage of metallic arsenic ranging from 12 per cent to .2 per cent. The great majority of these are strong percentages of arsenic which are not effective in control work on this ant and are unsafe to have on the premises, especially where there are children.

In the fall of 1908 the University established a laboratory in East Oakland for the study of this pest, part of the results of which were published in October 1910, including the formula for a weak arsenical solution that has proven so effective as a control measure. To L. H. Day, an assistant in the laboratory, is due the first proof of the greater efficiency of this strength of poison.

About this time the City of Berkeley appropriated five hundred ($500.00) dollars for a campaign against the pest; this work was carried on by L. J. Nickels[1] under the plan outlined by Professor Woodworth. At this time there were but two small colonies in Berkeley, one covering about two blocks, the other parts of four blocks. Considering the seriousness of the pest and the smallness of the infestation, it was considered advisable to attempt eradicating the ants. A careful survey was made and every effort used to secure the coöperation of all residents in the affected areas, to the end that all supplies of food except the poisoned bait might be shut off from the ants as far as possible, ant syrup in small perforated containers was placed in every lot. To supplement the poisoned bait a solution of cyanide (2 oz. sodium cyanide to 1 gallon of water) was used on the nests wherever found, the entire expense of labor and material being borne by the city. The manufacture and distribution of the ant syrup was done entirely by Mr. Nickels or an assistant. This plan was tried for several months and although the ants were not exterminated they were controlled, and to the extent that invasions of houses in the infested areas immediately ceased or were rare and of short duration and after a time were unknown; even at a time of the year when they are most annoying and though the ants were present in the yard. Control, that is freedom from ants as a house pest, was attained although the desired result, eradication, was not achieved. This immunity was attained by thus reducing their numbers. When the ants can be controlled so that they are not a serious pest and the territory is not increasing the work justifies the effort.

Because some of the Berkeley colonies crossed the line into Oakland it was very evident that eradication would be impossible without joint action with that city, therefore a successful effort was made to extend the work to the Northern section of Oakland.

It was soon seen, however, that eradication was going to be an impossibility, at least with the funds that could be made available, and the whole attempt was dropped.

In 1915 the City of Piedmont took official recognition of this pest and asked the University for assistance in carrying on control work. At this time only four or five blocks of the town were known to be

[1] Jour. Econ. Ent. IV, 4, Aug. 1911.

infested and a somewhat similar campaign to the one in Berkeley and Oakland was carried on by the author. This effort differed from those previously undertaken in that no attempt was made to eradicate but from the first the idea was control. As a control measure the previous campaigns had been completely successful.

The method consisted in the use of paraffined paper bags, perforated at the bottom to allow free access of the ants. In this bag was placed a sponge saturated with the ant syrup. The formula for this syrup is as follows:

[1] 1 oz. sodium arsenite;
16 lbs. sugar;
Water to make three gallons of syrup.

A supply of the prepared bags was placed in convenient places in the infested yards and the sponges refilled as often as necessary. In some cases cyanide solution was used on the nests. Preparation and distribution of the material was done by one man working part time in the employ of the city. He also answered all calls for assistance to any part of the city and whenever an infestation of Argentine ants was found, work was begun in that vicinity.

Piedmont was peculiarly subject to new infestations since the greater part of their potted plants, nursery stock, manure, and building materials are brought from the adjoining city of Oakland, which even at this time contained large areas of ant infested territory and had ceased doing anything to control them. In this way new infestations are constantly begun in Piedmont but by prompt control measures the spread of the ant was restricted and also the annoyance to householders was almost completely eliminated. City control was continued for about three years; the first year the total cost was three hundred ($300.00) dollars, the second year, on account of several new infestations, the expense was slightly more but less than four hundred ($400.00) dollars and this for a total area of sixteen blocks scattered in every part of the city, besides inspection of the entire city. In the third year small tin cans were substituted for the paper bags, this reduced the amount of refilling necessary as larger amounts of syrup could be left in the containers so that in spite of an increased territory, the cost remained about the same. The work was dropped at this time from lack of funds.

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[1]Instead of buying prepared sodium arsenite (which is quite variable in strength) it is now made according to the following formula.

1 oz. white arsenic;
2 oz. sal soda or 1 oz. sodium hydroxide;
8 oz. water.

Boil until clear and combine with 16 pounds of sugar and sufficient water to make three gallons.

During this time the infested areas in the adjoining cities of Berkeley, Oakland, and Alameda had increased enormously in spite of the work done by the residents to control the ants; in some cases a single family would spend from twenty to thirty dollars a year for ant pastes and yet not control them. Alameda was now practically a solid infestation, Oakland has perhaps half its territory infested. In Berkeley the infestation had increased from five blocks to one hundred and sixteen or twenty while in Piedmont the increase had been from four to about thirty blocks and with far less annoyance to the householders than in the other cities. Invasions of the house, when occurring at all, being sporadic and only for a short time instead of lasting the greater part of the year. This result being attained at a total cost of about eleven hundred ($1100.00) dollars for three years. And now after over a year of no effort the ants are only beginning to make trouble.

In 1915 Berkeley again appropriated funds for control work, the present campaign being in charge of W. A. Gregory. The work attempted is purely control, no effort being made to force measures at any point, but wherever assistance is asked for, the city, through its health department, takes charge of the control measures and bears all expense. At the end of the present fiscal year, one hundred and sixteen out of one hundred and thirty-three infested blocks are being treated, the total cost for the year's campaign being sixteen hundred ($1600.00) dollars or about one dollar and twelve cents $(1.12) a block per month.

While the remedy has been available to all, and most of the drug stores in the infested districts manufacture it under the name of the Argentine Ant remedy but of course at a much higher price than the wholesale rates at which the municipality can furnish it, and while the University has given directions and sent circulars to all who are interested in control work, yet the ants continue to increase and many householders fail to find relief from the insect even though time and money are spent freely in the attempted control.

Some give up and move to uninfested localities, increased difficulty is found in retaining tenants in the districts, rents are lowered, and even realty values fall, not from the lack of spending money but because it has not been used properly. These results show that simple as the process is, the best results are secured when the municipality assumes the responsibility and places an expert in charge of the work.

1st. This shows in the more certain control since only a portion of the people have success with the remedy;

2d. The lessened cost,—much less, experience has shown than the community spends; and,

3d. The greater safety, since there will be no necessity of keeping a stock of the poison in the house.

The trustees of every city infested by the Argentine Ant can thus provide the means of avoiding the lowering of the value of their residence property due to the presence of this insect.

CHAIRMAN H. J. QUAYLE: This paper is now open to discussion.

DR. E. G. TITUS: In the paper read the date of the first collecting of the Argentine ant is given as 1908. I took it in the year 1905 at Ontario, Cal.

MR. H. S. SMITH: What influence has Argentine ant on the numbers of scale insects? Professor Lounsbury reports the black scale as a pest only after the appearance of the Argentine ant in South Africa?

CHAIRMAN H. J. QUAYLE: The soft brown becomes specially serious under its influence. The ants keep off the parasites and the absence of parasitism is noticeable in the case of this scale. It has not been noted, however, in connection with the black scale.

MR. H. S. SMITH: The Argentine ants cause the disappearance of ladybird beetles in breeding cages.

DR. E. G. TITUS: I saw the ants eating the eggs of ladybird beetles at New Orleans.

CHAIRMAN H. J. QUAYLE: The next paper has been prepared by J. G. Bridwell of Honolulu, H. T. and will be read by Mrs. Bridwell who has come for this purpose.

BREEDING FRUIT-FLY PARASITES IN THE HAWAIIAN ISLANDS

By J. G. BRIDWELL

Among the fruit-fly parasites brought to Honolulu by Professor Silvestri from Africa and Australia in 1913 for the Board of Agriculture and Forestry of Hawaii were three *Opiine Braconids* attacking maggots while in the fruit. Difficulties encountered in breeding these in captivity resulted in the loss of *Opius perproximus*. *Opius humilis* and *Diachasma tryoni* only were established in the Hawaiian Islands by liberating the parasites under tents over coffee trees in Kona, Hawaii, the tents being left upon the trees for about ten days and the fruit left undisturbed. It fell to the writer to handle material from which *Opius humilis* was later recovered. The material so recovered permitted experiments which established a successful method of breeding the species in captivity which has since facilitated the multiplication of *Opiine* parasites and the simple cage devised has proved adaptable

for several purposes besides. These experiments and others relating to the adaptability of the parasite to its host in various fruits were carried on in the latter part of 1913 and the early months of 1914. The writer's sudden and unforseen departure in June, 1914, for the west coast of Africa interrupted these experiments and has prevented an earlier report upon them.

At the time of Professor Silvestri's arrival in Honolulu in May, 1913, no method of breeding generation after generation of *Opiine Braconids* (or, indeed, other normally mating *Braconids*) in captivity had been worked out. Accordingly the material of the *Opiines*, *Opius humilis* and *Diachasma tryoni*, brought with him by Professor Silvestri, and those emerging soon after, were divided into two lots, one of which was retained in captivity for breeding and the other liberated by Mr. D. T. Fullaway, as previously mentioned, in the Kona coffee fields. The material of *Opius perproximus* was at the time, June 13, 1913, reduced to a single female and this was retained in the insectary.

Upon Professor Silvestri's departure the breeding work was carried on according to his plans by Mr. Fullaway and the writer, the work upon the *Opiines* falling to Mr. Fullaway. The methods employed were briefly as follows: The parasites, both sexes together, were kept in 6-inch test tubes and provided with food (honey and water) upon leaves. The tubes were kept in cardboard trays lying down and shaded and partially darkened by a covering paper. When it was desired to employ them in breeding, fruit was placed on dampened sand in tall, narrow jars placed on their sides with the bottoms toward the light. The parasites were permitted to escape from the tubes into the jars and remained there for some hours. The fruit and damp sand had a tendency to "sweat" the glass and great care was necessary to avoid the destruction of the parasites through their coming in contact with the wet glass. The fruit-fly puparia from fruit exposed to the parasites were kept with sand in shell vials of about 1-inch diameter until the parasites emerged with the flies. The net results of the use of this method were as follows:

Diachasma tryoni, 334, of which 19 from a single lot of puparia were females.

Opius humilis, 56, all males.

Opius perproximus, 17, all males.

The last emergences were on August 18 and upon the writer's taking up the direction of the breeding work on October 1, only a few lingering males of *D. tryoni* were in the insectary. From the areas in Kona where the *Opiine* parasites had been liberated June 13, small lots of coffee were brought into the insectary and on October 10 and 26 individuals of *Opius humilis* emerged from the puparia so secured. A

single female and 3 males from this lot were employed in a single experiment to test the writer's theory of the cause of the failure of the method previously employed.

The damp atmosphere of the fruit enclosed on damp sand in a jar and the resulting dew on the glass formed one obviously unfavorable environment for the delicate parasites. The absence of females, except in a single lot of puparia, suggested failure to secure proper mating and the production of males by parthenogenesis. Observation showed that males placed with females in tubes usually showed but little sexual excitement until exposed to strong light or sunlight. A tube containing both sexes when exposed to sunlight for a very short time became an animated scene and the males became highly excited, running about with their wings elevated and repeatedly attempted mating. In a test tube, however, the attempts at mating usually proved abortive and in only a very few instances was actual copulation observed.

It seemed then only necessary to expose the fruit to the parasites in a cage allowing free access to the air and perhaps a moment's exposure to the sunlight to start mating in a more favorable situation. The writer had just been reading of the success in breeding dipterous parasites of the gipsy moth in small wire cylinders and it occurred to him preferable to make his first attempt in such a cage. Accordingly he constructed a crude cylinder about 5 x 2½ inches and placed in it coffee berries infested with fruit-fly maggots, a single female and several males of the parasite, which he left for two days. From the resulting puparia ten parasites emerged, equally divided between the sexes.

A subsequent sending of the coffee berries from Kona gave ample material for breeding but for some months' time failed for further experiment, the work of editing the Silvestri report and seeing it through the press preventing further experiment at the time and for some months the parasites were bred exclusively by the tent method, the fruit from each tent being collected and the parasites bred out in the insectary. Subsequent experiments confirmed the impression of the conditions necessary for success and ultimately the following apparatus and method was adopted and put into use. In Africa, also, this cage was successful and upon his return in December, 1915, the method was still employed in the insectary.

It was desired to keep several males and females of the parasite with the fruit until decay compelled their removal to preserve them alive and recover them, to make the cage as light and airy as conveniently might be and to prevent the parasites getting away any considerable distance from the fruit or from their food. To prevent the parasites from becoming entangled and destroying themselves, it is necessary to have the cage within free from crevices into which they may pene-

trate in their efforts to escape. The cages finally adopted were made from ordinary nursery flats 16 x 12 x 3 inches. The flat, as made up, is used for the base of the cage. The cover, or as may be said, the cage itself, is made from the material used for the ends and sides of the flats, cut to make a frame fitting quite loosely into the flat and a top of fine copper wire cloth fastened on with wooden strips like the screen on screen doors.

A layer of dry sand is placed in the bottom of the box. A basket, made by bending up the edges of ¼-inch mesh wire screen, and fitting easily into the top, is filled with a single layer of the fruit employed. The test tubes containing the parasites and some leaves with honey and water dotted over them, are placed on the fruit. The cotton plugs are removed from the tubes to permit the escape of the parasites and the top is quickly put in place over the basket of fruit and pressed firmly down into the sand which effectually seals the cage and prevents the escape of parasites or the entrance of ants. The maggots emerging from the fruit cannot penetrate into the sand to any great depth. The wire basket prevents the fruit, wet from the oozing juices, from coming into contact with the sand and caking it so as to interfere with the sifting of the pupæ from it. When it is desired to remove the parasites this cage is opened in the insectary and after a time they will go to the window. The insectary of the Board of Agriculture and Forestry has a room admirably adapted for the purpose. For such use a room should have the following qualifications: It should be small, should have a shelf-table built in tightly against the base of the window occupying the side of the room above the table, in the northern hemisphere, with a northern exposure. There should be no other strong light and the interior should show no cracks or crevices and should be painted white. The ceiling should be everywhere in easy reach standing, a narrow shelf should extend around the room and ample ventilation can be provided with small openings covered with very fine mesh copper wire screening.

The method described is a practical one and permits the production of large numbers of parasites with facility but it has the disadvantage of not permitting observations to be made upon the actions of the parasites. Mr. C. R. Pemberton of the Federal Bureau of Entomology, who is at present engaged in a detailed study of the life-history of the *Opiine* fruit-fly parasites, and has already secured most interesting and valuable results from his work, has been able to secure partial mating and satisfactory oviposition by the use of the dried fruits in small quantities in glass. The mating seems to be more successful in the larger tubes he has used for the purpose.

A series of experiments were carried on in the spring of 1914 to

ascertain if *Opius humilis* would attack the fruit-fly in its various host fruits, employing tents in part and cages in part. The work carried on later by Dr. E. A. Back, of the Federal Bureau of Entomology, has confirmed the impression made by this preliminary series. No fruit adequately experimented with failed to produce parasites though in highly variable numbers. The rate of reproduction of the parasites was found to be somewhat greater with favorable conditions than that of the fruit-fly. The tentative conclusions then arrived at have required no modification as the result of the later work. It seemed then, as it does now, that under favorable conditions, from the thin meated fruits, such as coffee, terminalia and elengi, the parasites might well practically eliminate the fruit-fly but in the case of fleshy fruits, such as mango, guava, peach and chinese orange, the mechanical difficulty of parasitizing the maggots would prevent the parasite being any great factor.

As the result of three years' connection with the work on the fruit-fly in Hawaii, Africa and Australia, the writer is convinced that under Hawaiian conditions, the fruit-fly must be controlled by the use of parasites to reduce the flies to the point where the poisoned balls will be effective. The work done seems to make this conclusion certain. Under South African conditions, which simulate more closely those in California, it is quite certain that Mr. Mally has made as complete a commercial success of the poisoned bait method as is ordinarily obtained in economic entomology.

SECRETARY E. O. ESSIG: There are a number of applications for membership which should be signed and referred to the membership committee of the general association and for this purpose I move that the chair appoint a membership committee for this purpose.

This motion was duly seconded and passed.

CHAIRMAN H. J. QUAYLE: As this committee must consist entirely of active members it will be necessary for Dr. E. G. Titus and myself to act. The meeting is adjourned until tomorrow morning at 10 o'clock.

The meeting of August 11 was called to order by chairman H. J. Quayle at 10 o'clock. a. m.

CHAIRMAN H. J. QUAYLE: For the first thing we will have the report of the nominating committee.

REPORT OF THE NOMINATING COMMITTEE

The report of the nominating committee for the officers of the Pacific Slope Branch of the American Association of Economic Entomologists for the ensuing year is as follows:

For chairman, A. W. Morrill, Phœnix, Arizona.
For vice-chairman, R. A. Cooley, Bozeman, Mont.
For secretary-treasurer, E. O. Essig, Berkeley, Cal.

For the membership committee

One year, A. L. Melander, Pullman, Wash.
Two years, E. G. Titus, Logan, Utah.
Three years, H. J. Quayle, Riverside, Cal.

(Signed) E. G. Titus,
H. S. Smith.

This report was duly accepted by the members and the officers as nominated were declared elected.

Chairman H. J. Quayle: Is there any other business to come before the house at this time?

Dr. E. G. Titus: I wish to offer the following resolution:

Resolved, That we appreciate the use of the high school as a meeting place and express our sincere thanks to the City Board of Education for the use of the same.

This resolution was duly adopted by the house.

Chairman H. J. Quayle: We shall now take up the remainder of the papers. The first one this morning is by Mr. H. S. Smith.

AN ATTEMPT TO REDEFINE THE HOST RELATIONSHIPS EXHIBITED BY ENTOMOPHAGOUS INSECTS[1]

By Harry Scott Smith, *Superintendent California State Insectary, Sacramento, California*

In any field of endeavor it is desirable occasionally to review the past, making such readjustments as may seem necessary in order to provide a more secure basis for future work. In zoölogy the taxonomist accomplishes this by monographing, as necessity may demand, the group in which he is interested. The monographer performs a valuable service, since he not only standardizes that which has been done by others before him, placing each known species in its proper phylogenetic position in the group, but he defines the species as well and, if his results be worthy, makes it unnecessary for future students to go back of his monograph. In this way much valuable time is saved, and many needless misunderstandings, through lack of proper definition, are avoided.

In biological work names are quite as necessary as in taxonomy, and a careful definition of a biological phenomenon is fully as important as a correct description of a genus. Just as descriptions of genera must occasionally be altered as new species are made known, just so must the terms in biology occasionally be altered to keep pace with the advance of knowledge in biology. Definitions in a growing science

[1] Occasional contributions from the California State Insectary, No. 2.

are things to be modified and limited, just as the science itself is modified and limited.

The use of entomophagous insects in economic entomology, while not exactly a new branch of science, has experienced a considerable development in recent years. This development has necessitated more careful biological work on entomophagous insects, and has indirectly resulted in the adoption of a number of new terms to designate, among other things, the many different types of host-relationships exhibited. Many of the terms having to do with insect parasitism have "just growed." They have never been defined, and as they originated at a time when our knowledge of the subject was much less than at present, we find that they frequently include, under one name, two or more distinct phenomena. In other cases two or more terms have been used to designate the same phenomenon. The host-relationships of entomophagous insects is a subject of considerable complexity and an accurate definition of the different types is essential to a clear understanding of them. It has seemed to the writer that to redefine the old terms now in use, to standardize, in a way, the terminology of insect parasitism, would be to render a service to the workers in that branch of entomology. In the following pages will be found the writer's contribution, in so far as his limited knowledge of the subject will permit, to such a redefinition.

The term parasite itself is one of the most difficult to define and it will not be attempted here. In this paper, when the term parasite is used, it will be understood to refer to certain temporary entomophagous insects only, and not to those insects such as Mallophaga, etc., which depend upon animals other than Arthropods for their subsistence.

In recent years there have appeared two papers,[1] by Messrs. Fiske and Pierce, in which certain phenomena connected with host-relations were defined. These will be referred to frequently later on.

Parasitism and Predatism

The first and simplest division usually made of entomophagous insects is based on their method of feeding. These divisions are usually designated as parasitic insects and predaceous insects, and these terms are generally used in what seems to be the correct sense. A parasitic insect, in the generally accepted sense, is one which passes its entire larval state within or upon a single individual host. A

[1] Fiske, W. F.: Superparasitism: An Important Factor in the Natural Control of Insects, Jour. Econ. Ent., vol. III, pp. 88–97; Pierce, W. D.: On Some Phases of Parasitism displayed by Insect Enemies of Weevils, Jour. Econ. Ent., vol. III, pp. 451-458.

predaceous insect is one which requires more than a single individual of the host species for completing its development and this requirement would seem to necessitate a more or less well developed means of locomotion. There is, however, no definite division between parasitism and predatism and in certain cases it is difficult to know whether to call an insect a parasite or a predator. A case of this kind is the Pteromalid scale-parasite *Scutellista cyanea*. If we follow the definition given above *Scutellista* might come in either the parasitic or predaceous category. The female Scutellista deposits her eggs beneath the adult black scale. The parasite larva, however, feeds upon the eggs of the host and requires a large number, frequently several hundred, to complete its development, although it always matures beneath and upon the eggs of a single host scale. The question then arises as to whether we should call Scutellista a parasite of the black scale or a predator upon black scale eggs. The definition of the term parasite might be enlarged to fit cases of this kind by saying that a parasite is an entomophagous insect which requires but a single individual host insect, or the eggs of a single individual, to complete its development. But in calling to mind the life-histories of various kinds of parasites we find that even this enlargement of the definition as generally understood will not serve to define the host-relations in all cases. *Macrorileyia œcanthi* Ashm., a Chalcidoid parasite (?) of the tree-crickets, carries us a step farther. This so-called parasite lives in the pith of the twigs in which the tree-crickets have deposited their eggs and upon which it feeds. Unlike Scutellista, however, it may, and frequently does, feed upon the eggs of more than one individual tree-cricket, and by reason of this approaches still more closely to predatism. There are many examples of this type of host-relations. In Italy there occur two Chalcidoid enemies of the alfalfa weevil, one a Pteromalid and the other an Eupelmine, of similar habits. The eggs of the alfalfa weevil and other species of Phytonomus are deposited within the stems of the host-plant in clusters. The two parasites mentioned here feed upon these eggs not as egg-parasites but as predators, often devouring egg-masses from several different weevils. Excepting for the fact that one is protected and the other feeds in the open, there is no essential difference between these so-called parasites and the larva of Leucopis, for example, which feeds upon the eggs of mealy-bugs, or the larva of the Brown Lacewing, Hemerobius, which feeds upon the eggs of the same host. Scymnus, Hyperaspis and many other ladybirds have similar habits. In view of these facts, therefore, we can scarcely say that there is a definite line of demarcation between parasitism and predatism, but the two, like geographic races, intergrade, the two extremes being quite distinct. In fact there

are some species of insects, like *Aphelinus mytilaspidis*, for example, which are both predaceous and parasitic, feeding either upon the adult insect, or the progeny beneath the parent insect. The distinction between parasitism and predatism is of no great importance, but it is well to bear in mind that many of the so-called parasites are parasites only because they belong to a parasitic group, and not by reason of their method of feeding.

The interrelations of the parasites themselves are quite complex and, it seems to the writer, not as yet well defined. A knowledge of these interrelations is of not a little importance when the subject of the control of noxious insects by their insect enemies is under consideration. There have been used in the past a number of phrases and terms to designate the different kinds or types of host-relations and of interrelations of the parasites themselves, many of them used in one sense by one author and in an entirely different sense by another. Obviously this is not conducive to a clear understanding of the subject and should if possible be avoided. Some of these terms and phrases are hyperparasitism, secondary parasitism, tertiary parasitism, superparasitism, accidental secondary parasitism, cannibal superparasitism, mixed superparasitism, true secondary parasitism, multiple parasitism, etc.

Hyperparasitism

The term hyperparasitism is generally used to denote any stage of parasitism other than primary. That is, either a secondary parasite or a tertiary parasite is a hyperparasite. This is a useful term in the entomological vocabulary and is generally confined to the above meaning, although some use it synonymously with "secondary." Misuse of the term occasionally occurs when, for example, parasites of ladybirds are called hyperparasites. There is certainly no valid excuse for calling a parasite of ladybirds a hyperparasite, since it is not a parasite of a parasite, but is simply a primary parasite of Coccinellidæ. The fact that ladybirds are usually beneficial should have no bearing in the case, and such use of the term is only confusing. Neither should primary parasites of any other predaceous insects such as Leucopis, Chrysopa, Syrphus, etc., be called hyperparasites, although we find such use of the term occasionally in entomological literature.

Indirect Parasitism

Indirect parasitism, which is a type of hyperparasitism, is most closely related to secondary parasitism, and has not heretofore been defined. This type of host-relationship can best be illustrated by examples. One of the most noteworthy instances of this type is the Chal-

cidoid parasite *Perilampus hyalinus*,[1] and is, so far as I know, the first case on record of an indirect parasite. *Perilampus hyalinus* has an hiatus in its known life-history, since we know nothing at the present time of its oviposition habits. But we do know that it attacks the larvæ of *Hyphantria cunea*, not for the purpose of breeding upon Hyphantria, as it is unable to do this, but for the sake of the primary parasite which it harbors. Strangely enough, in the case of this particular parasite, it does not matter much what the primary parasite is, just so it is an internal parasite of *H. cunea*. It will be seen then that in the type of host-relationship known as indirect parasitism there are always three insects necessarily concerned simultaneously if the indirect parasite is to succeed in reproducing: first, the host of the primary parasite; second, the primary parasite, and third, the indirect parasite. No other host conditions will suffice. It will readily be seen that this type of host-relationship represents a very different kind of parasitism from that occurring where a parasite oviposits directly into the primary and yet both have always been known as secondary parasitism. Types of host-relationship so widely different should be distinguished by different terms. I would restrict the term indirect parasitism to the type of symbiosis similar in a general way to that occurring in *Perilampus hyalinus*. As a definition of indirect parasitism I would suggest the following: *Indirect parasitism* is that type of symbiosis in which the one parasite attacks a host insect upon which it itself is incapable of breeding, for the sake of the primary parasite which it may harbor. Since the biology of so few parasitic insects is known it is impossible to say just to what extent indirect parasitism occurs in nature. Besides *Perilampus hyalinus* one or two other species of this genus are known to have this habit, although several species are known to be true primary parasites. In the Ichneumonoidea this type of parasitism is known to occur in *Mesochorus pallipes*, a parasite of the Braconid, *Apanteles fulvipes*, which is in turn a parasite of the gypsy moth in Europe. Since several other species of this genus are parasitic on Apanteles species, it is probable that many of them have the same habit. To this class belong also a number of hyperparasites of scale insects. Among them are species of the genus Eusemion which are parasites of Microterys and Aphycus, in their turn parasites of the soft brown scale, species of Cheiloneurus which breed on various parasites of mealy-bugs and scales, and Cerchysius, a parasite in one case of Microterys on soft brown scale, and in another on *Scutellista cyanea* and *Tomocera californica*, parasites of the black scale.[2] Species

[1] The Chalcidoid Genus Perilampus, and its Relations to the Problem of Parasite Introduction. Bul. 19, Tech. Ser., pt. IV, Bur. Ent., U.S.D.A.

[2] *Vide* Timberlake, "Parasites of Coccus hesperidum," Jour. Econ. Ent., vol. 6, pp. 293-303.

of Figitidæ also have this habit, ovipositing into aphids in order to breed upon the aphidiines infesting them. Considered from an economic standpoint, these indirect parasites are of no greater importance, are capable of no greater harm, than are the other hyperparasites. In fact they are less to be feared as a general rule since their life-histories are more complex and the more complex an insect's life-history is, other things being equal, the less possibility there is of its becoming abundant.

Secondary Parasitism

The type of host-relationship most closely allied to indirect parasitism, and most generally confused with it, is secondary parasitism. While these two forms of symbiosis bring about the same final result, *i. e.*, the destruction of the primary parasite, the manner of accomplishing this end is very different. Strictly speaking, a secondary parasite is merely a primary parasite of a primary parasite. While this is also true of the indirect parasite, they differ in that the adult of the indirect parasite does not oviposit directly in or upon its host, but into or upon the host of the primary.[1] The adult of the secondary parasite deposits its eggs directly into or upon the body of the young primary. The life-history of the true secondary is very simple as compared to the complex life-history of the indirect parasite. In the one case two insects only, the secondary and its host the primary, are concerned. In the other three insects, the indirect parasite, the primary parasite and the host of the primary are all directly concerned.

True secondary parasitism is of very common occurrence in nature, and is of great importance in the natural control of insects. Practically all species of primary hymenopterous parasites, and especially the cocoon-forming groups of which the Ichneumonoidea compose the majority, are greatly subject to attack by these insects. The Tachinidæ and other parasitic Diptera are also destroyed in large numbers. True secondary parasitism is of most common occurrence among the Chalcidoidea and is found especially in the families Eulophidæ and Pteromalidæ. It also occurs in the Eurytomidæ, Elasmidæ, Callimomidæ and Chalcididæ. It occurs very uncommonly, if at all, in the Encyrtidæ, since in that highly specialized family indirect parasitism takes the place of secondary parasitism. I do not call to mind at this time any case of secondary parasitism, as here defined, in the Proctotrypoidea or Cynipoidea, although in the latter indirect parasitism occasionally occurs. Secondary parasitism should occur in both of these superfamilies, however, since many species are parasites of Diptera and they will undoubtedly be found to attack some of the

[1] In the case of *Perilampus hyalinus*, the oviposition habits are unknown, but the young parasite larva or *planidium* is first found on the outside of the caterpillar.

parasitic species.[1] In the Ichneumonoidea secondary parasitism occasionally occurs, especially in the Cryptinæ.

As a definition I would suggest the following: Secondary parasitism is that type of symbiosis where a parasite destroys a primary parasite by direct attack, and not through the medium of the host of the primary parasite.

Since this type of insect has the same relation to primary parasites as the latter have to insect pests, it naturally follows that they are an extremely important consideration in the control of injurious insects. They are in our native fauna responsible in many cases for the ineffective work of primary parasites which would otherwise be of great practical value. In the introduction of new beneficial insects it is obviously of greatest importance to guard against the introduction of these secondaries. Many primary parasites of little importance in their native habitat might, by introducing them into new localities, become of great practical value through the elimination of their secondaries, especially if these secondaries have no counterpart in the new locality. Occasionally, however, the newly introduced parasite is immediately attacked by secondaries native to the new locality and which had as their original host species of the same genus as the parasite introduced. A noteworthy instance of this kind occurred at the Gypsy Moth Parasite Laboratory of the U. S. Department of Agriculture.[2] *Apanteles fulvipes*, a common parasite of the gypsy moth in Europe and Japan, was introduced as a most promising species. In Europe it was found to be attacked by something like twenty-five species of secondaries and indirect parasites, and other hyperparasites. In Japan at least thirty species of hyperparasites occurred. During the first generation on American soil seventeen species of hyperparasites, for the most part different species but the same genera as those occurring in Europe and Japan, attacked *Apanteles fulvipes*.

In this case the elimination of the secondaries probably did not have a very important bearing on the success of the introduction, since the introduction of hyperparasites having the same habits as native parasites would merely serve to eliminate to a large degree the native hyperparasites, leaving the total percentage of mortality about the same as before. The introduction of secondaries which have no counterpart in the new fauna, however, would have an entirely different effect and the greatest care should be exercised to eliminate any hyperparasites which would form a new element in the local fauna. Obviously the only safe way of doing this is to eliminate them all.

[1] Since writing the above I have come across a record of true secondary parasitism among the Proctotrypoidea by Mr. Swezey of the Sugar Planters' Station of Honolulu. A species of *Ceraphron* was found to parasitize *Haplogonatopus*, a Dryinid.

[2] Howard and Fiske: Bul. 91, Bur. Ent., U.S.D.A.

Tertiary and Quaternary Parasitism

Parasitism of a stage beyond that of secondary—if we disregard those cases of accidental or chance parasitism—is of not at all common occurrence. I do not at this moment recall a single authentic case of true quarternary parasitism, although such have been recorded. It will generally be found in the instances where parasites are recorded as quaternary that they are only accidentally so, the same species being by nature either secondary or tertiary. Some parasites such as *Dibrachys boucheanus* are so omnivorous in their food habits that they will develop on practically any parasite larvæ enclosed in a cocoon or puparium. This being the case, if they oviposit into a cocoon containing larvæ of a tertiary parasite they are able to develop on the tertiary larvæ and then they become numerically speaking quaternary parasites. They are not, however, obligatory in this rôle, and if they are to be designated as quaternary at all the term should be modified by the word accidental. There are grave doubts as to whether an obligatory quaternary parasitic insect exists.

Obligatory tertiary parasitism does exist in nature and will no doubt be found to be a fairly common phenomenon when the life-histories of more parasitic insects are thoroughly known. The best instance of true tertiary parasitism is that of the Eulophid, *Asecodes albitarsis*. The writer has made hundreds of dissections of cocoons of various microgasterine parasites in New England and in every case Asecodes was found to be a true tertiary parasite, breeding generally upon *Dibrachys boucheanus*, a true secondary. Other species of the Entedonini will without doubt be found to belong to this category.

Dr. L. O. Howard in his interesting paper on the parasites of the Tussock moth, at the close of his chapter on the interrelations of the parasites, says: "We would naturally have expected a period of abundance of tertiary parasites to have followed that of the secondary parasites. This, however, was not the case. Tertiary parasitism seemed to be comparatively rare and was only definitely proven in the case of *Asecodes albitarsis* and *Dibrachys boucheanus*, the latter being usually a secondary parasite. . . . There must be a limit to this work of parasite upon parasite at some point and it seems certain that tertiary parasitism is rare and that quaternary parasitism seldom occurs."

As mentioned above, Dibrachys is in reality a secondary and becomes tertiary in this case only through accident and its omnivorous food habit. Asecodes is, however, an obligatory tertiary parasite. I would define then as tertiary parasitism that type of symbiosis where a parasite is obligatory upon an obligatory secondary. A true quaternary would necessarily be obligatory upon an obligatory tertiary parasite. I believe with Dr. Howard that there must be a limit

to this work of parasite upon parasite and while it is perhaps unscientific to allow one's opinions to outstrip the facts, especially when so few life-histories of parasites are known, I doubt if true quaternary parasitism as defined above really exists among entomophagous insects. Accidental quaternary parasitism does of course occur in the case of omnivorous or general feeders such as Dibrachys or Melittobia and so far as this type of insects is concerned there is practically no limit to the numerical relations which may develop. Dibrachys will, for example, breed upon Asecodes and in its turn Asecodes will breed upon this generation of Dibrachys, and while this sort of thing can hardly go on *ad infinitum* as Burns would have us believe, it would certainly continue as long as the food supply lasts.

Superparasitism and Multiple Parasitism

Superparasitism has been defined by Fiske (*loc. cit.*) as that form of symbiosis resulting "when any individual host is attacked by two or more species of primary parasites or by one species more than once." We have under superparasitism as defined by Fiske two quite distinct phenomena. These were later designated by Pierce (*loc. cit.*) as cannibal superparasitism and mixed superparasitism. In a previous article Mr. Pierce gave to the latter phase of parasitism the term accidental secondary parasitism. This phase or rather these phases of parasitism have been so ably treated by the two entomologists mentioned, that there remains little to be said in this connection and those interested are referred to the two articles for further information. However, since the avowed purpose of this paper is to standardize the terminology of the host relations of entomophagous insects the subject cannot logically be left with two terms for the one phenomenon in one case and one term for two phenomena in the other.

The writer would suggest that the term superparasitism be restricted to those cases where there is a superabundance of parasites *of a single species* (cannibal superparasitism of Pierce). It frequently happens, especially when the total percentage of parasitism runs abnormally high, that the mother parasite deposits many more eggs than can possibly reach maturity on a single individual host, or in other cases, after one female parasite has laid her quota of eggs another female of the same species, lacking the ability to distinguish between parasitized and unparasitized hosts, deposits a further supply in the same individual. This phenomenon alone I would term superparasitism, leaving the other phase included in Fiske's superparasitism to be termed multiple parasitism (Pierce's accidental secondary parasitism and mixed superparasitism).

By way of definition I would suggest the following: Superparasitism

is that form of symbiosis occurring when there is a superabundance of parasites *of a single species* attacking an individual host insect. Multiple parasitism is that form of symbiosis where the same individual host insect is infested simultaneously with the young of *two or more different species* of primary parasites. The term multiple parasitism has already been used by Pierce to designate gregarious parasites and while I dislike to use the same term for a different phenomenon I know of no unused expression which fits so well this phase of parasitism.

In a brief paper like this it is possible only to touch upon the main headings of the extensive subject of host-relationship of entomophagous insects. It has been attempted to define only the most important divisions, but each of those is of course divisible into a number of lesser types. While the writer is not so rash as to believe that there will be a general acceptance of these definitions by entomologists, he does hope that they will be of some assistance to students of this most interesting phase of biology.

CHAIRMAN H. J. QUAYLE: The next paper will be on the dispersion of scale insects by the wind.

DISPERSION OF SCALE INSECTS BY THE WIND[1]

By H. J. QUAYLE, *University of California, Citrus Experiment Station, Riverside, California*

The manner and extent of dispersal of many insects have been largely conjectural until recent years, and even now exact data have been secured for comparatively few species. Of course, we have had records of the great distances that certain flying insects may travel. It is only necessary in this connection to mention such insects as the migratory locust, *Schistocerca peregrina*, which has been found five hundred miles east of its home in South America and is supposed to have crossed over even to Africa, or our own Rocky Mountain locust, which has gone one thousand miles from its breeding ground, or certain moths that have been seen over four hundred miles at sea.

It is only recently, however, that we have come into possession of definite data as to how far such flying insects as the house-fly or such non-flying forms as gipsy moth larvæ may travel. Without authentic data, a few hundred feet or a few hundred yards was thought to be the limit of travel of the house-fly. The work of Arnold, Copeman, et al.

[1] Paper No. 36, Citrus Experiment Station, College of Agriculture, University of California, Riverside, California

Hewit, Hine, Howard, Hodge, Hindle, Zetek, and Parker, however, has given us positive data as to the dispersal of the house-fly, *Musca domestica*.[1] Parker has given us evidence for the greatest range of dispersion, namely, 3,500 yards, but this distance, as he infers, does not represent the possible extreme spread, because his captures were not beyond the distance indicated.

Burgess[2] and Collins[3] have determined that the gipsy moth larvæ may be carried by the wind for a distance of thirteen and one-half miles. Munger, Stabler,[4] and Weldon have shown that the almond mite, *Bryobia pratense*, may be carried by the wind a distance of 650 feet and to an elevation of 50 feet. This definite information concerning the agency of the wind in spreading insects has a very important bearing on any control measures that may be employed. The question, of course, is not so pertinent for insects that are controlled by an arsenical spray because the protective poison is present on the plant, and it makes little difference whether the insect comes from an adjoining tree or from a neighboring orchard.

In the citrus sections of California, where more regulation and enforcement of insect control are probably practiced than in any other part of the world, the matter of neighboring groves serving as a source for reinfesting treated ones is a question of considerable importance. Our previous work[5] has shown that there is little possibility of a young scale insect making its way from one tree to another by its own powers of locomotion. It has also been shown that insects and birds, as well as man in his usual cultural operations, may be factors in spreading the scales, and these agencies may account for the origin of an infestation at a considerable distance. But more important, we believe, than all of the above agencies in distributing scale insects, is the wind. While many of our horticultural officers have appreciated the importance of the spread of the scales from adjoining groves, the question has been doubted by some entomologists. It was for the purpose of securing, if possible, some definite data that experiments were undertaken along this line.

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[1] See Jour. Econ. Ent., vol. 9, no. 3, p. 353, 1916, for these references.

[2] Burgess, A. F. The Dispersion of the Gipsy Moth. Bul. 119, Bur. Ent. U. S. D. A., 1913.

[3] Collins, C. W. Dispersion of Gipsy Moth Larvæ by the Wind. Bul. 273, Bur. Ent. U. S. D. A., 1915.

[4] Stabler, H. P. Red Spiders Spread by the Wind. The Monthly Bulletin, Cal. State Com. Hort. II: 12, p. 777, 1913.

[5] Quayle, H. J. The Red Scale. Cal. Exp. Sta. Bul., p. 129–131, 1911. The Black Scale. Cal. Exp. Sta. Bul., p. 160–165, 1911. The Purple Scale. Cal. Exp. Sta. Bul., p. 330–332, 1912. Locomotion of Certain Young Scale Insects. Jour. Econ. Ent., vol. 4, no. 3, p. 301, 1911.

The first series of experiments was to determine to what extent the young of the black scale, *Saissetia oleæ*, might be captured on tanglefoot flypaper. After the paper had been exposed to the sun for two or three days, it was found that the sticky material became very hard and firm. It was at first thought that this fact would make the paper of little value for entangling the scales, but upon examination, it was seen that many were captured nevertheless. It should be noted, however, that in the discussion that follows, all time records are for but two or three days, the limit of effectiveness of the material, regardless of how long the sheets might have been exposed. If the tanglefoot had remained effective longer, there would, of course, have been many more scales captured. On the other hand, there is some little advantage in the handling and examination of the sheets occasioned by the hardening of the material. The sheets were placed in different situations and at different distances from infested trees as indicated below.

THE CAPTURE OF YOUNG BLACK SCALE ON TANGLEFOOT SHEETS

Sheet No.	Exposure	Height	Distance	Date Placed, 1915	No. of Scales
1	South	5 feet	30 feet	June 28	146
2	West	2 "	30 "	" 28	360
3	East	2 "	30 "	" 28	156
4	North	5 "	30 "	" 28	228
5	North	6 "	30 "	" 28	192
6	South	5 "	30 "	" 28	96
7	East	5 "	Center tree sq.	" 28	84
8	West	3 "	Ibid.	" 28	504
9	West	3 "	35 feet	" 28	168
10	West	3 "	35 "	" 28	300
11	West	3½ "	45 "	" 28	432
12	West	3½ "	Center tree sq.	" 28	831
13	West	3½ "	Ibid.	" 28	1056
14	West	3½ "	20 feet	" 28	147
15	West	3½ "	35 "	" 28	228
16	West	4 "	13 "	" 28	840
17	East	4 "	27 "	" 28	246
18	West	3 "	100 "	" 28	523
19	West	3 "	200 "	" 28	361
20	West	3 "	250 "	" 28	93
21	West	5 "	450 "	" 28	31
22	West	3 "	Center tree sq.	Sept. 1	2
23	West	3 "	Front of tree	" 1	4
24	West	3 "	Ibid.	" 1	1
25	West	3 "	Center tree sq.	" 1	3

The twenty-one sheets put out on June 28, 1915, entrapped a total of 7,262 scales or an average of 346 scales for each sheet. Only four sheets fell below 100, while the maximum number was 1,056. The distance from the infested trees ranged from 10 feet to 450 feet, the average distance being 70 feet. The prevailing direction of the wind was from the west and southwest. On the sheets facing west, the average for each sheet was 408. On those with a south exposure, the average was 241, north exposure, 210, and east exposure, 162. However, because of the difference in the number of sheets with the differ-

ent exposures, and the fact that infested trees occurred on more than one side in some cases, no definite conclusions are drawn from the above figures as to the number of scales captured in relation to the prevailing direction of the wind.

In the case of the black scale, which has a more or less definite annual period of young production, dispersal would be expected to occur largely during that period. The only other time would be when the scales are migrating from the leaves to the twigs, or when they have detached themselves from the plant for any other reason, and at such times, on account of the increased size of the insects, their dispersal by the wind would not be so great.

The above conclusions are supported by our experiments as shown by the last four sheets referred to in the table. These sheets were exposed on September 1, after the hatching of the scales had ceased, and they were settled on the leaves and twigs. The sheets were placed in the same grove as those of June 28, and 15 feet was the greatest distance away from infested trees. The average number captured on these sheets was 2½ scales as against an average of 346 scales on the sheets placed on June 28. The important period of dispersal of the black scale, as well as of the citricola scale and others having usually but one generation a year, is, therefore, from April to September, or the period when the great majority of active young appear. This fact would not apply so strictly to scales having three or four generations a year, as the red, yellow, purple, and soft brown scales, since young may be present in greater or lesser numbers throughout the warmer portion of the year, or from March to December in California.

The data thus far secured have reference to the black scale, but Mr. Bishop of Orange County and his inspector, Mr. Paddock, had tanglefoot sheets so placed as to capture the red scale, *Chrysomphalus aurantii*. These sheets were submitted to the writer for examination. The distance ranged from 6 feet to 150 feet, and young red scales were found on most of the sheets.

In the experiments with the tanglefoot paper noted above, there was no obstacle between the sheets and the infested trees to interfere with the free carrying of the scales. In order to determine what happens under normal conditions in the grove, the following experiment was carried out:

A four-acre block of grapefruit was selected that was fumigated in 1914 with the result that practically 100 per cent of the black scale were killed. A careful examination of the block in April, 1915, resulted in finding no scales, and in midsummer all of the scales present were young scales indicating that they had not come from parent scales on the same trees, but from neighboring trees. This block of clean

trees was surrounded by severely infested orange trees on the west, south, and east sides. On the north was an abrupt slope of barren ground. There were 25 trees north and south and 16 trees east and west in the block. The examination for scales was made on August 20, 1915. Twenty-five leaves were selected at random from the north, east, south, and west sides of the tree respectively, making a total of 100 leaves from each tree.

Below is represented the block of trees on which examination of

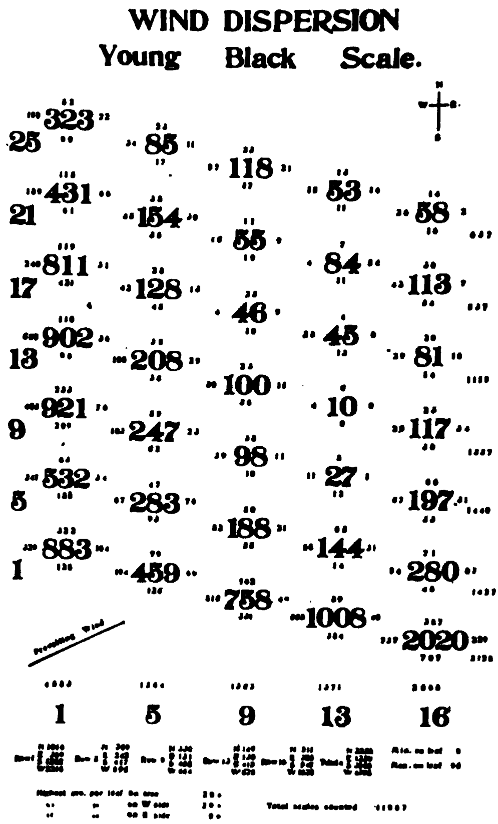

Fig. 35. Data from experimental plot. (Original).

young scales was made. The small figures represent the number of scales on 25 leaves on the respective sides of the tree, while the large number, which is the total of the small numbers, represents the number of scales on 100 leaves of the respective trees.

From the above it will be seen that there is a total of 4,803 scales on 100 leaves of every fourth tree on the west row, while the fifth row to the east drops down to 1,564 scales, or a difference of 3,239. The first

row on the south side shows 5,128 scales as against 1,427, or a difference of 3,701 on the fifth row from the infested trees. Taking the first row on the west again, there is a total of 2,218 scales on the 25 leaves on the west side of every fifth tree, as against but 369 scales on the same number of leaves on the east side of the same trees. The prevailing direction of the wind, it will be noted, was from the southwest.

This four-acre block, as the results have shown, was not large enough to determine all the possibilities of the experiment. It was scarcely anticipated that the scales would have spread over the entire area in one season, and since the infested trees were on three sides with a slight wind blowing from the opposite direction at night, as compared with that of the day, there appears to have been some movement from this direction. However, on the east row of the block, immediately adjoining infested trees, there are more scales on the west side of the trees than on the east side. The figures are 1,020 for the west side and 388 for the east side. With a few exceptions, all of the trees show more scales on the west than on the east side of the tree. On tree 13 in row 1, for example, 660 scales are found on the 25 leaves on the west side as against 36 scales on the same number of leaves on the east side.

From a practical point of view the agency of the wind in spreading plant-feeding or disease-bearing insects is of very great consequence. In the case of the block of trees referred to, the work of fumigation in 1914 was so satisfactory that the trees should have gone several years without treatment. As it was, in spite of the fact that 100 per cent of the scales were killed, the trees could not go untreated over a single year and had to be fumigated in 1915. Other host plants growing in the vicinity, particularly border host trees, are, likewise, directly responsible for reinfesting treated trees.

During the present season we varied our experiments on wind dispersal somewhat by having more direct control of the origin of spread. This was done by cutting branches, badly infested with the black scale, and suspending them on a pole in the midst of barren ground. Three tanglefoot sheets were placed in the form of arcs of circles at distances of 26, 46, and 70 yards respectively on the leeward side of the infested branches. The length of the inner arc was about 15 yards and of the outer arc about 45 yards. Three sheets were also placed on the windward side at a distance of 15 yards from the infested branches. A total of 60 young black scales were captured on the nine sheets on the leeward side, and none on the three sheets on the windward side. The maximum number on a single sheet, 24, was found on the one directly in front of the point of origin. The total of the three sheets in this arc, a distance of 26 yards, was 37 scales. The total on the next three

sheets in the next arc, a distance of 46 yards, was 17 scales, and on the next arc, a distance of 70 yards, 9 scales. All of these 60 scales came from an amount of branches that would be represented by a three- or four-year-old tree. On the three sheets on the windward side, but 15 yards distant, there were no scales.

Summary

Young black scale, *Saissetia oleæ*, have been found to be carried by the wind, as represented by their capture on tanglefoot sheets, at different distances up to 450 feet. This distance does not necessarily represent the extreme dispersal since provision for capture was not made beyond 450 feet.

The young of the red scale (*Chrysomphalus aurantii*) were captured on tanglefoot sheets at distances ranging from 30 to 150 feet.

It is possible that many of the scales on these sheets were dead at the time of capture, but that there were many alive is shown by the next statement.

Young black scale were distributed over an entire four-acre block of trees, without question chiefly by the wind, in a single season. They may be distributed by the wind over a much greater area than this.

That the spread is chiefly in the direction of the prevailing wind is shown from the figures given for the block of trees, as well as by the captures on the tanglefoot paper.

In the case of young black scale, dispersion by the wind occurs largely during the period of young production from April to September. With scales having three or four generations a year, the young producing period is prolonged and consequently the liability of the young to be carried by the wind is prolonged.

The data presented on the dispersion of scale insects by the wind, which data represent only a preliminary report, emphasize the practical importance of carrying on fumigation work solidly over as large an area as possible.

H. S. Smith: Were the scales experimented with young newly hatched larvæ or older forms?

Chairman H. J. Quayle: They were newly hatched larvæ.

D. L. Crawford: Which is the most responsible for the spread of scale insects, wind, insects or birds?

Chairman H. J. Quayle: Wind by far; birds and insects are very small factors.

Dr. E. G. Titus: I have found that the wind will carry young thrips at a height of 20 feet.

E. L. Prizer: Are birds and insects more likely to carry mealybugs than wind?

CHAIRMAN H. J. QUAYLE: The mealy-bugs are probably more influenced by the wind.

L. P. ROCKWOOD: Are wind barriers of any use in preventing the spread?

CHAIRMAN H. J. QUAYLE: Yes, but they might have to be very high as red spiders have been caught on a tank tower 50 feet high.

The next paper will be presented by Mr. L. P. Rockwood.

SPOROTRICHUM GLOBULIFERUM SPEG., A NATURAL ENEMY OF THE ALFALFA WEEVIL

By L. P. ROCKWOOD, *U. S. Bureau of Entomology, Forest Grove, Oregon*

The parasitism of insects by the fungus known at present as *Sporotrichum globuliferum* Spegazzini, although at one time seriously questioned and even denied by eminent mycologists, is now generally acknowledged. That this fungus is probably the most efficient natural enemy of the chinch bug, *Blissus leucopterus*, under conditions favorable for its growth and spread, is well known. However, very little data has appeared as to the occurrence of the fungus as a natural enemy of insects other than the chinch bug. We have long lists of insects of various orders recorded as furnishing a sub-stratum for the growth of this fungus, but few or no observations of the fungus as a factor in the natural control of these insects.

This fungus has come under my observation in connection with various insect hosts both in the field and laboratory at various times during the past two years. Its relation to the alfalfa weevil, *Hypera variabilis* (*posticus*) Hbst., in Utah in 1914, is dealt with briefly in this paper.

OCCURRENCE OF THE FUNGUS ON THE ALFALFA WEEVIL

The fungus *Sporotrichum globuliferum* Speg., was first found on the alfalfa weevil near Salt Lake City, Utah, on March 14, 1914. It was frequently met with and could easily be found on weevils and other insects under alfalfa plants from that time until May. This was a time of considerable precipitation and the ground in alfalfa fields was moist to wet most of the time. The time of greatest abundance of the fungus was April 21 to 29. At this time at least one weevil killed by the fungus could be found under almost every plant examined. On April 29 this was particularly true. On this date 11 weevils killed by the fungus were found under one alfalfa plant covering an area of about four square feet on a high bank outside the irrigated area.

This early mortality of weevils caused by *Sporotrichum globuliferum* is undoubtedly of considerable importance as the death of the adults

at this time, before and during oviposition, helps to reduce the destructive new generation of larvæ. No other natural enemy of like importance was observed at this season. In the early spring, the optimum conditions for the growth of the fungus are likely to be found in all the alfalfa fields on the East Bench of old Lake Bonneville regardless of the irrigation practice. The ground-frequenting habits of the weevils at this time, the season of mating on the ground under the early low growth of alfalfa, especially expose them to infection by frequent contact with the bodies of insects covered with the spores of the fungus.

Later in the season when the spring rains have ceased, the fungus seems to be restricted to fields which are generously irrigated and have a heavy close stand of alfalfa. One such field was examined on July 29 and 28 weevils with a pure growth of *Sporotrichum* were picked up in a short time. Such mortality at this late date is of slight importance, however, as this is the time when the over-wintered adults are dying off naturally. Yet it is worthy of note that this field for which a generous water supply was available and which was therefore lavishly irrigated has never been seriously injured by the weevil; at least so the rancher informed me, and I was inclined to believe him as it was certainly unusual for a Utah farmer to deny injury from the weevil. The fungus was observed in this field in abundance on September 10. Other insects killed by the fungus, notably *Sitones* sp., were also abundant in this field.

A spontaneous outbreak of the disease occurred among weevils of the new generation in a rearing cage at the laboratory about November 17 and caused a high mortality. Many weevils also died of the disease in an outdoor hibernation cage during the fall and early spring.

The Fungus

The fungus on *Hypera variabilis* (*posticus*) Hbst. was determined as *Sporotrichum globuliferum* Speg. by Dr. Flora W. Patterson, Mycologist of the Bureau of Plant Industry, U. S. Dept. of Agriculture.

The fungus is probably distributed over all of the Americas and has been recorded as found on the bodies of insects of several orders.

The macroscopic appearance of the fungus on weevils varies with the conditions under which the exterior growth of the fungus developed. In a confined dark cage with little or no ventilation, the fungus usually completely envelops the weevils in a loose, fluffy, cottony growth of fungus mycelium in the outer strands of which the scattered balls of spores are developed, the balls being usually separated from each other by an appreciable distance. Weevils partially buried in moist locations in the débris under alfalfa plants in the field also often

show this fluffy, cottony growth which sometimes spreads out over the rotting débris to an area of one half inch or more. Under the usual field conditions or in well ventilated, well lighted cages, the fungus forms a dense felted mass, usually confined to the elytral, thoracic, and abdominal sutures, which are often completely outlined by the white bands of the fungus mycelium. Upon this short felted growth of mycelium, the balls of spores appear densely packed together. Old specimens of the fungus assume a well-defined cream color.

It was found by experimentation that the macroscopic appearance of the fungus on weevils killed by mechanical or chemical means before exposure to the fungus presented a relatively different appearance from that on weevils killed by the fungus. In the case of weevils killed before infection, the fungus appeared as a very thin, long, loose, cottony covering, almost cloudy in appearance, nowhere localized in a thick mass. Moreover, in all such cases, contamination of the typical fungus with the well known saprophytic fungi of the genera *Penicillium* and *Mucor* invariably occurred under the somewhat septic conditions incident to the experiment. Weevils killed by the fungus always developed a pure dense growth of the typical fungus, and saprophytic fungi never developed upon them until after the parasitic fungus had matured and disintegrated. Weevils killed by the fungus are usually found in a life-like attitude with legs and antennæ extended as if death overtook them suddenly while on the move.

Laboratory Experiments

No cultures of the fungus in artificial media were attempted. Spore germination studies by the hanging drop method in Van Tieghem cells were made for the purpose of gaining information for the better interpretation of dissections and blood examinations. The formation of the so-called "cylinder-gonidia" of DeBary[1] were thus studied and later identified in the blood of infected weevils.

Several infection experiments with *S. globuliferum* on *H. variabilis* (*posticus*) were carried on in the laboratory at different times, always with 90–100 per cent mortality from the fungus. The infection cages varied from tightly closed tin tobacco boxes with bottom layers of moist sand or garden loam on which the weevils and their food were placed, to open glass battery jars on the bottoms of which was placed moist sand or garden loam to a depth of one-half inch to three-fourths inch, the food and weevils being then introduced and the jars closed with cheesecloth tops, thus allowing the air free access to the interior of the cage. These cages were moistened from time to time as they

[1] DeBary, A.: Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria, p. 372 Oxford.

dried out, and fresh alfalfa was supplied as necessary. All cages were placed in a conservatory having two walls glassed in and connected with a room of the laboratory, thus insuring more light and circulation of air than is ordinarily found indoors. All cages were disinfected before use by being washed in 20 per cent carbolic acid and rinsed in tap water. Infection was, with the exception of the first experiment, by introduction into the cages of insects showing well developed fruiting fungus. Alfalfa not eaten by weevils was allowed to accumulate as débris in the bottom of the cages.

Experiment I

March 23: Five weevils were infected by contact with a fungus-covered weevil in a moist chamber for 2 hours. They were then placed in a battery jar cage partially filled with moist sand and alfalfa was introduced as food.

April 3: One weevil dead.

April 7: Second weevil dead.

April 9: Third weevil dead.

April 10: Fourth weevil dead.

April 25: Fifth weevil dead.

All developed a pure growth of *Sporotrichum globuliferum* within two to three days of death.

Experiment II

March 25: Thirteen weevils were placed in a small vial with a fungus-covered weevil and left in a moist chamber for 4 hours. The weevils were then placed in a tight tin tobacco box partially filled with moist sand. Alfalfa was placed in the cage as food. Later a weevil showing a good growth of fungus was placed in this cage under the alfalfa.

March 30: Three weevils dead, 2 from fungous disease; 1 from unknown cause.

April 3: One more weevil dead. A living weevil which seemed to be ailing was dissected. The blood of the abdomen contained several fungus hyphæ of various lengths. The blood of the thoracic region showed more numerous fungus hyphæ and these were generally longer and further advanced than those in the abdomen. Incipient branching of the hyphæ was observed in several cases. Fungus bodies practically identical with the "cylinder-gonidia" observed in Van Tieghem cells were observed in the blood.

April 6: Contents of cage were examined. Found 12 dead weevils.

All developed typical fungus, except the weevil noted March 30 as dead from unknown cause.

Experiment III

April 5: Twelve weevils were placed in a tobacco-box cage with a fungus-covered specimen. Moist sand and alfalfa were used as in Experiment II.

April 6: One weevil dead of fungus. This weevil was probably infected when collected.

April 8 and 11: One weevil was dissected on each date without finding signs of fungus.

April 15: All weevils dead.

April 21: All developed typical fungus except the two dissected.

Experiment IV

April 7: Twenty weevils were placed in a tobacco-box cage as before with moist sand.

April 8: One weevil dead from unknown cause. One living weevil was dissected but no signs of fungus were seen.

April 15: Two weevils dead.

April 16: An enfeebled weevil was dissected. The abdomen and thorax were well supplied with fungus hyphæ varying from "cylinder-gonidia" to long, considerably branched hyphæ.

April 18: A dead weevil showing no exterior growth of fungus was dissected. The body was found to be packed with a reddish-brown mass of fungus hyphæ.

April 20: All weevils dead but one.

April 21: Last weevil dead.

All not dissected developed typical fungus.

Experiment V

April 16: Fifty weevils were placed in glass battery-jar cage, the bottom of which was covered with garden loam. The cage was infected by placing in it 4 fungus-covered specimens.

April 21: Twenty-five more weevils placed in this cage.

April 28: Weevils dying in numbers.

May 7: All weevils dead.

Experiment VI

May 8: Thirty weevils were placed in a battery-jar cage with garden loam as before. The cage was infected by the introduction of several fungus-covered specimens.

May 18: All but 3 dead.

May 20: All dead and all developed typical fungus.

Experiment VII

Aug. 7: Twenty-two weevils reared from pupæ about July 15 were placed in a battery-jar cage with moist sand. Cage was infected by introducing several fungus-covered specimens.

Aug. 20: Several weevils dead.

Aug. 31: A few still alive.

Sept. 18: Four weevils still alive.

Oct. 13: Last weevil dead.

All developed typical fungus.

Experiment VIII

Sept. 30: Fifty weevils collected from a ditch bank, were placed in a battery-jar cage with moist garden loam; infection brought about as in previous experiment.

Oct. 14: Three dead.

Oct 20: Many dead and showing fungus.

Nov. 4: Forty-five weevils dead of fungus, 4 weevils alive, 1 lost.

Nov. 18: One weevil still alive.

Nov. 20: Dissected the last living weevil. Found a few scattering *Sporotrichum* "cylinder-gonidia" in the blood. Most of them were of irregular or indistinct outline as if undergoing cytolysis.

This cage contained 47 weevils dead and showed typical exterior growth of *S. globuliferum*, 1 weevil dead with body filled with the hyphæ of the typical fungus, 1 [illegible] sp., probably dead from some other cause.

Check to Experiment VIII

Sept. 30: Started cage of 50 weevils under exactly similar conditions to Experiment VIII except that no fungus was intentionally introduced.

Nov. 25: One dead of *S. globuliferum*.

Dec. 18: Forty-five living weevils, 3 dead (2 of *S. globuliferum*), 1 lost, 1 killed by *S. globuliferum* removed.

Note: No *Sporotrichum* appeared in this cage until 2 months after starting experiment.

Summary of Infection Experiments

In the early experiments when tight, unventilated tin boxes were used, complete mortality from the fungus disease occurred within two weeks, in the case of Experiments II and III in 12 and 10 days respectively. Conditions were of course optimum for the growth of the fungus and very unnatural for the weevil.

In the early battery-jar cage experiments under supposedly less favorable conditions for the growth and spread of the fungus, almost as good results were attained, the majority of the weevils dying of the disease within ten days to two weeks. In the case of Experiment VI, where the weevils were less crowded than in any experiment but Experiment I, all died in 12 days. In the case of Experiment I where conditions most closely approached those in the field in the proportion of the number of weevils to the area of the cage, a somewhat longer time was necessary to kill 3 of the 5 weevils, namely 17, 18 and 33 days respectively. The last weevil to die in this cage probably either escaped or conquered the first infection which in this case was attempted by a short exposure to the fungus spores followed by isolation in a clean cage.

In the later experiments with weevils of the new generation, considerable resistance to the fungus developed. At this time a majority of the weevils were killed in 3 weeks, but often several were able to survive for one or two months. Some of this difference in mortality between the two seasons may possibly be attributed to the fact that the cages dried out faster in mid-summer and fall, so that often the sand or dirt in the cage became almost bone-dry before this condition was rectified by sprinkling the interior of the cages. However, dissections and blood examinations of some of the weevils from these cages indicated that some individual weevils were more or less immune at this season. This immunity is deduced from the cytolytic phenomena observed in the blood of the weevil dissected under Experiment VIII.

It may be of interest to note in this place that Hypera adults appear to be rather resistant to the well-known entomogenous fungus *Metarrhizium anisopliæ* Sorokin. Laboratory attempts to infect weevils

with this fungus obtained from Elaterid larvæ from Hagerstown, Md., through the courtesy of Mr. J. A. Hyslop of the U. S. Bureau of Entomology, showed less than 50 per cent mortality from this fungus after nearly three months' exposure to the fungus under conditions exactly similar to those of the *Sporotrichum* experiments. Moreover, it took almost a month to kill the first two weevils by means of this fungus.

Conclusion

The entomogenous fungus, *Sporotrichum globuliferum* Speg., develops spontaneously as an infectious disease of the alfalfa weevil, *Hypera variabilis* (*posticus*) on the bench lands of the Salt Lake Valley in the early spring. Infection experiments show the weevil to be very susceptible to fungus infection at this season, a complete mortality from the fungus being secured in breeding cages in usually two weeks' time. The ground-frequenting habits of the alfalfa weevil at this season render it particularly liable to infection from contact with fungus-covered insects.

The new generation of weevils is less susceptible to the fungus during the periods of æstivation and hibernation in the summer and fall. Moreover favorable conditions for the growth and spread of the fungus are unlikely to occur in Utah at this time.

The period of greatest mortality from the fungus disease, coinciding as it does with a period of great potential injury from the pest, namely, the oviposition period, makes the fungus worthy of record as a natural enemy of the alfalfa weevil.

H. S. Smith: Does the fungous disease attack only the adult weevils?

L. P. Rockwood: The larvæ and pupæ are also attacked but because they are usually on the leaves and tops and not on the damp ground they seldom become infected.

Dr. E. G. Titus: There are about 30 hosts attacked by this fungus, but in no case has it been noticed to be of economic importance though under observation since 1910.

H. S. Smith: There is a fungus which works very effectively on the alfalfa weevil in Italy, attacking the larvæ.

L. P. Rockwood: *Sporotrichum* is very widely distributed and is of more importance than it is usually credited with.

Chairman H. J. Quayle: The next paper by Mr. Asa Maxson will be read by the secretary.

SOME UNPUBLISHED NOTES ON PEMPHIGUS BETÆ DOANE

By Asa C. Maxson, *In charge of Insect Investigations for the Great Western Sugar Company, Longmont, Colo.*

In April, 1912, the writer began a study of the life-history and habits of the sugar beet root-louse, *P. betæ* Doane, in coöperation with the Colorado Experiment Station. The work was done at Longmont, Colo., the funds being furnished by the Great Western Sugar Company in whose employ the writer has been since 1910.

While the main facts in connection with the life-history of this insect have been given by Gillette and Bragg, Journal of Economic Entomology, vol. 8, no. 1, p. 97, there still remain a number of unpublished observations which have a bearing upon the life-history and habits as well as the control of this pest.

Hibernation of Apterous Form

In order to ascertain to what extent the apterous lice live over from season to season in the soil of old beet fields, three fields were examined during the second week of April. At this time the spring field work had not begun and no weeds had started in the fields. The examination was made by digging holes about 10 inches in diameter and from 8 to 10 inches deep. The soil from these holes was carefully examined by crumbling it with the fingers.

In field No. 1, which had grown sugar beets continually for at least 6 years, holes were dug at both ends and in the centre. Of the 101 holes dug in this field the soil from 52 per cent yielded living root-lice. The east end of the field is higher and drier than the west end. Sixty per cent of the diggings in this part of the field yielded living lice while but 25 per cent of those at the west end produced lice. In the centre section of the field 55 per cent of the diggings produced lice.

Field No. 2 grew its first crop of sugar beets in 1911, the previous crop being alfalfa. The soil from 56 per cent of the holes dug in this field yielded living lice.

Field No. 3 grew its first crop of beets in 1911, also, following a crop of barley. In the soil from 76 per cent of the holes dug in this field living lice were found.

Hibernating Lice as a Source of Crop Infestation

In the determining of this point three cages 8 x 3 x 3 feet, consisting of a light frame work covered with muslin, were used. These cages were placed at the east end of field No. 1. They were placed end to

end and about 8 feet apart. A board 1 x 12 inches formed the base of the cages and this was sunk into the ground to a depth of 10 inches. These cages were put in place May 8 at which time the young stem-mothers on the cotton-woods were in the first and second instars. Beet seed was planted in cage No. 1 and in the spaces between the cages on this date. Seed was planted in cages Nos. 2 and 3, June 4 and 27, respectively. After the seed was planted in the cages they were not opened until the migration of lice from the cottonwood trees was practically over when the weeds were pulled and the beets irrigated.

September 28 the beets in the cages and in the spaces between them were dug and a careful examination made for root-lice. It was found that the beets in cage No 1, the earliest planted one, were all infested. Those in cage No. 2 were infested but to marked degree less than those in cage No. 1. The beets in cage No. 3 were entirely free of lice. All beets in the spaces between the cages were infested, also.

Host Plants

Our knowledge of the apterous forms of the various species of the genus Pemphigus is so limited that it would hardly be safe to say that all root forms of this genus represent any particular species. For this reason in discussing the host plants it should be remembered that some of them may not be hosts of *P. betæ* since a determination of the apterous lice is not possible.

The perennial plants which have been found to be hosts of *Pemphigus* sp. are of especial interest because of the fact that they play a double rôle in the life-cycle of these insects. The following perennials were found to be hosts of *Pemphigus* sp.: Yarrow, *Achillea* sp.; wild aster, *Aster multiflora; Solidago* sp.; *Rumex* sp.; *Agropyron* sp.; and *Polygonum aviculare.*

Summer colonies were found on the roots of *Chenopodium album,* garden beets, sugar beets, and *Cycloloma atriplicifolium. Pemphigus* sp. have been reported on carrots and sweet clover as well as alfalfa; however, the writer has never been able to verify these reports. A very close examination of many alfalfa fields, while the alfalfa was being plowed up, has never revealed a single Pemphigian on the roots. Lice of this genus have been repeatedly taken on turnips in the south.

Effects of Lice on Sugar Content and Yield of Sugar Beets

From the standpoint of the sugar manufacturer this is a very vital point. The reduction of the per cent of sugar in the beets not only reduces the quantity of sugar which can be made from a given acreage which means a smaller year's profit for the manufacturer but also

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makes the manufacture of sugar at a profit impossible if the sugar per cent drops below a certain level.

In order to ascertain the effect of the beet root-louse upon the percentage of sugar in the beets a series of 61 five-beet samples was taken during the second week of September 1912. All of these samples came from an area not to exceed 20 square rods in extent. Thirty-one of these samples were made up of beets free or nearly free of root-lice, the remaining thirty being made up of beets which were infested but not to a degree sufficient to effect their appearance. The uninfested samples averaged 14.62 per cent sugar. The lowest sample tested 12.9 per cent and the highest 15.3. The infested samples tested 13.85 per cent as an average and ranged from 11.7 per cent to 15.7. The difference in favor of the uninfested samples was 0.77 of 1 per cent in sugar content and 2.11 per cent in apparent purity.

Again in 1914 a similar test was made. This time 40 samples were taken, 20 infested and 20 uninfested. The former averaged 13.12 per cent sugar, the individual per cents ranging from 11.2 to 16.9 per cent. The latter averaged 14.06 per cent with a range of from 12.2 to 16.8 per cent sugar. Of the infested samples but one was above 14.4 per cent while of the uninfested there were 6 above this point. The uninfested samples averaged 0.94 of 1 per cent higher than the infested.

In weight the infested samples averaged 4.98 lbs. The heaviest sample weighed 6.5 lbs. and the lightest 3.5 lbs. The average weight of the uninfested samples was 6.7 lbs. The heaviest weighed 9 lbs. and the lightest 5.5 lbs. It is a well-known fact that among beets grown under the same conditions the large ones average lower in per cent sugar than the small ones. This being the case the small infested beets should have contained a higher per cent of sugar than the larger uninfested ones had not the effect of the lice been the cause of the lower weight as well as sugar content. Figuring from the above and assuming that we have a perfect stand of beets which would mean a beet every foot in the row and the rows 20 inches apart or 26,000 beets per acre the lice reduced the yield 4.55 tons per acre. However, not more than 50 per cent of the beets of a field could safely be considered as infested to this degree in the average. This would mean that the loss really was not far from 2.25 tons per acre as a result of the root-lice.

At an average price of $5.80 per ton this means a direct loss of $13.05 to the grower, without taking into consideration the loss in sugar per cent.

Control Measures

It has been shown by J. R. Parker, of the Montana Experiment Station, that irrigating at the time the spring migrants of the root-

louse are leaving the galls on the leaves of the narrow-leaved cottonwood trees has a very marked effect on the number of lice on the beets at harvest time. The writer has observed this fact in connection with plots used in determining the relative effects of early and late irrigation of beets. In all cases the plots irrigated during late June have been much freer of root-lice at harvest than those irrigated the fore part of July.

Rotation of crops appear to have no effect upon the degree of infection. In fact many times the first beet crop on alfalfa or grain land is more seriously damaged by root-lice than any other.

NATURAL CHECKS

While in the galls the lice are preyed upon by a capsid and the larvæ of a syrphus fly. In the soil many lice are destroyed by the fungous disease, *Empusa aphidis*. The larva of the syrphus fly *S. pauxillus* was taken feeding in a colony on a beet root. The flocculent larvæ of the little lady-beetle, *Scymnus collaris*, has been noted in numbers among the root-lice in the field. The larvæ of *Hippodamia convergens* has been taken feeding upon the root-lice where the soil was cracked about the beet. In California the larvæ of *Scymnus appaculus* is known to feed upon the beet root-louse.

LIFE-CYCLE

The writer has succeeded in following the life-cycle from the gall to the gall in the insectary. Spring migrants of *Pemphigus balsamiferæ* Williams have been taken from the galls and colonized on sugar beets which were grown from seed in sterilized soil and in muslin-covered cages. The sexual forms have been secured on twigs of the narrow-leafed cottonwood tree, *Populus angustifoliæ* on the leaves of which tree the galls appear. These twigs were placed in the cages. This work was done in 1914. The sexuals mated normally and the females produced eggs on the twigs mentioned. In the spring of 1915 the eggs produced larvæ which were placed on a seedling narrow-leaf cottonwood. These larvæ located on the upper side of the leaves just as the buds began to open and there formed the typical *P. balsamiferæ* galls. The migrants from these galls proved to be without doubt *P. balsamiferæ*.

SYNONOMY

In 1900 Professor Doane described the beet root-louse from the root form in bulletin No. 42, of the Washington State Agricultural College, giving it the name, *Pemphigus betæ*. In the late Thomas Albert Williams' "Aphididæ of Nebraska" which was published in 1910 we have the description of the spring forms and the galls. This form Mr. Wil-

liams gave the name *Pemphigus balsamiferæ*. Professor Doane's name having the priority, Williams' *P. balsamiferæ* must be considered as a synonym of *P. betæ*.

Lice Liable to be Confused with P. betæ

In some collections the spring forms of *P. betæ* are labeled *P. p-venæ* Fitch. The gall of *P. betæ* differs from that of *P. p-venæ* as described by Dr. Fitch by being on the under side of the leaf opening above while Dr. Fitch clearly states that the gall of *P. p-venæ* is on the upper side of the leaf opening below.

Many times there occur on the leaves of the same tree and the same leaf with the galls of *P. betæ* the galls of what the writer is considering *P. p-globuli* Fitch. These galls are on the upper side of the leaf at the base of the leaf. They are nearly circular in cross section while the galls of *P. betæ* are eliptical or narrowly oval in cross section. The alate lice from these galls differ in the number of secondary sensoria on joint VI of the antennæ. *P. betæ* has no sensoria on VI or at best very short oval sensoria which are not raised above the surface of the joint and not as long as the diameter of it. Joint VI of *P. p-globuli* has several annular sensoria. While *P. betæ* from the galls has always taken to the beet in the cages the migrants of *P. p-globuli* have uniformally refused to colonize on the beet roots.

Range of P. betæ

No report of the occurrence of *P. betæ* has been recorded from any locality east of western Kansas and Nebraska. The writer has collected *Pemphigus* sp. in most of the states west of the Mississippi but has never taken *P. betæ* either on sugar beets or on any Populus sp. east of the points mentioned. The range of the narrow-leafed cottonwood, *Populus angustifoliæ*, is given as from North Dakota to Washington and from New Mexico to California. It is probable that a better knowledge of the locations where these trees occur and beets are not grown in large acreages would reveal the fact that this insect's range extends as far east as that of the host tree.

In Colorado the number of narrow-leafed trees rapidly diminishes as we go eastward from the mountains.

There is a possibility that further study will show that some other of the *Pemphigus* sp. occur on the beet during the summer. The only species which the writer has not used in cage experiments is *P. p-ramulorum* Riley. With the exception of *P. balsamiferæ* all species have repeatedly refused to take to beets.

Chairman H. J. Quayle: This concludes the papers and the

meeting. The first convention has been satisfactory and well worth while. All members should work for the parent branch. This new organization means much not realized before, including the JOURNAL OF ECONOMIC ENTOMOLOGY, the opportunity to present papers and to meet other workers in this important field of scientific work.

The convention is adjourned.

The following paper was received too late for the meeting and is presented for publication in the proceedings for which it was intended.

BUCCULATRIX THURBERIELLA, A PEST OF COTTON IN THE IMPERIAL VALLEY[1]

By E. A. McGregor, *Bureau of Entomology, U. S. Department of Agriculture*

On the first of June of the present year a species of tineid larva was found devouring the leaves of cotton in certain fields near El Centro in the Imperial Valley of California. Reared adults were determined by Mr. W. D. Pierce of the Bureau of Entomology as *Bucculatrix thurberiella* Busck, a species which was collected in the summer of 1913 by Mr. Pierce on wild cotton (*Thurberia thespesoides*) at various points in Arizona.

Description

ADULT.—Busck's description[2] of the adult is as follows: "Face tuft, head and thorax white. Antennæ white with dark fuscous annulations. Forewings white; extreme costal edge blackish; an outwardly black streak beyond the middle of costa is continued as a very fine, easily lost line across the wing to a group of black scales below apex, where the cilia is also dotted with black; a few easily lost black scales on basal third of dorsum and a group of black scales on the middle of dorsum is followed by scattered light brown scales. The apical part of the wing above the oblique costal streak is dusted with brown and black scales. Cilia ochreous white. Hind wing and cilia ochreous white. Legs white on the inner side, black exteriorly; tarsi black with narrow white annulations. Alar expanse 7 to 8 mm."

LARVA.—Concerning the larva Busck merely states that it "is dirty white, rough skinned, with prominent white tubercles and with two dorsal rows of black dots, one on each segment. Head light ochreous with black eyespots and reddish-brown mouth parts."

In life the larva is rather of a greenish-amber color. Each segment, viewed dorsally, exhibits the following characteristics; a pair of large black spots at the anterior margin; a transverse row of 6 whitish tubercles situated just behind the black spots and extending from side to side; a second transverse row of similar tubercles midway between the former and the hind margin—all tubercles giving rise to a short bristle. Eighth segment from the head nearly obscured by a dusky area. Thoracic legs blackish. Head light ochreous with black eyespots and posterio-dorsal area of dusky color.

[1] Published by permission of the Chief of the U. S. Bureau of Entomology.

[2] Proc. Ent. Soc. of Wash., vol. XVI, no. 1, March 1914, p. 30.

Economic Importance

During the present (1916) season *Bucculatrix thurberiella* has been one of the few major pests of cotton in the Imperial Valley. One hundred cotton leaves were gathered on June 2 from a field heavily infested with this species, and the infestation was computed as follows:

Leaves (total)	100
Leaves free	22
Leaves supporting larvæ[1]	4
Leaves supporting pupæ[1]	32
Leaves showing work	42
Percentage infestation	78

Subsequent to the above date infestation reached an even higher degree, but by the first of July was somewhat checked by the work of parasites. The Bucculatrix larvæ, however, attained the ascendancy again about the first of August and at the present date (August 8) are probably the most abundant that they have been at any time during the season. In some fields not a leaf is free from the work of the species. Table I presents the results from the examination of 20 leaves picked at random about a field at El Centro, California.

Table I. Occurrence of Immature Stages of *Bucculatrix thurberiella* on Cotton Leaves

Leaf No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Average.
No. mines in leaf	13	76	12	8	15	20	16	18	38	12	20	12	11	5	7	18	28	20	24	5	18.9
No. molting cocoons on leaf	4	4	1	6	2	4	2	4	5	13	5	7	3	6	5	4	16	4	15	2	5.6
No. larvæ on leaf	2	3	4	2	2	1	2	2	4	3	3	6	0	2	0	3	3	1	4	1	2 4

The pest has been found in fields at El Centro, Imperial, Brawley, Westmoreland, Calipatria, Meloland, Seeley and Calexico, which demonstrates that it occurs in every cultivated part of the Valley.

The tineid caterpillar may be found in virtually every cotton field, but it appears to thrive best on plants which, for some reason, are stunted and non-vigorous. A 5-acre field of cotton, "volunteering" from last season's roots which had received no water since the occurrence of a rain in March, was early seen to be very severely attacked. A small plot of seedling cotton (see Pl. 36, fig. 1), growing near a hedge of tall eucalyptus trees, remained stunted for weeks, and these plants became very heavily infested. Tall cotton is similarly attacked (see Pl. 36, fig. 2) but is better able to withstand the work of the pest. When present, cotton clearly shows the effect of the caterpillar, the foliage being riddled and perforated, often, until little more than veins

[1] Also showing damage.

and epidermis remain (Pl. 37, fig. 4). Small, ill-nourished plants are usually killed, while larger plants are often severely injured. Occasionally larvæ feed upon the calyx and involucral bracts which results usually in the shedding of the form. On account of the thickly honeycombed nature of the leaf lesions, which is so characteristic of Bucculatrix-infested cotton, we propose as a common name for this species the "cotton leaf-perforator."

Life-History

The Egg.—The egg is very small, being barely discernible to the naked eye. It is projectile-shaped, pale straw-color, with about ten longitudinal ridges and intervening grooves, giving it a strongly fluted appearance. In addition to this, a reticulate system of smoky-colored mottlings decorate the surface. The egg is placed upright on the leaf, standing on its largest end. No preference seems to be shown in ovipositing as between the top and under sides of the leaf. Since we have been unable to induce egg-laying under control, it is impossible to present data as to the duration of the incubation period. Eggs in out-of-door locations on a few occasions have been observed 24 hours prior to hatching which indicates that the period is somewhat in excess of that interval.

The Larva.—First Instar.—Upon hatching the larva bores into the leaf directly at the point of attachment of the egg and begins to tunnel. The mine lies nearer the upper surface than the lower, and progresses tortuously, ever widening in calibre. The average total length of the tunnel, as determined from a measured series, is about one inch. When this instar is about completed an exit hole is cut through the upper epidermis, and the larva deserts for all time the inner tissue. Upon coming to the exterior the first instar individual occasionally feeds for a brief period on the upper leaf tissue. The time required for the completion of this instar is about three days.

When the feeding activities of this stage are finished the larva weaves a tiny circular web over some slight depression on the under side of the leaf into which it repairs for the first molt. The initial molting web consists of two fabrics, first a "fly" web of loose texture is woven and under this is spun the more compact fabric. A somewhat concealed aperture is left through which the individual makes its exit after molting. A large series of these primary molting webs averaged $^1/_{16}$ inch in diameter. The molting period covers about twenty-four hours.

Second Instar.—Upon the appearance on the leaf of the second larval instar, feeding at once begins. This may take place on either the upper or the under surface. The leaf tissue is devoured only to the opposite epidermis, but the remaining tissue often collapses, thus forming irregular-shaped lesions (see Pl. 36, fig. 2). After about 1.5 days at El Centro, the larva selects a concavity, normally on the under surface between two large veins, and spins the second molting cocoon. These are similar to the primary cocoons but are larger, averaging about $^3/_{32}$ inch in diameter. The larva lies in a looped position—head to tail. The quiescent period is determined from our data to be 1.1 days.

Third Instar.—At the conclusion of the second molt the larva of the third instar emerges and at once begins to feed in a manner similar to individuals of the second instar. This is the most aggressive stage and the one causing the greatest amount of injury to the cotton leaf. As a rule, not more than two or three larvæ occur on a single leaf, but occasionally as many as a half dozen have been seen. The last act of the third larval instar individual, after the completion of the pupal cocoon, is the shedding of the larval skin which occupies a position within the cocoon just behind

the posterior end of the chrysallis. Just prior to pupation the color of the mature larva undergoes a change from the olive-green of the active condition to a smoky-drab which is apparently indicative of maturity. The third instar at El Centro required during midsummer about 1.9 days for completion.

The Pupa

The pupal cocoon may be placed in one of several locations. It is occasionally seen at some point on a leaf; it is often formed on the leaf petioles; but most frequently it is placed at some point along the main or lateral stems (see Pl. 36, figs. 1 and 3). Just before making the cocoon a series of stout, upright bristles is placed in a graceful ellipse so as finally to surround the cocoon. These closely set stalks form a stockade and are intended, probably, as a protection against predatory species.

Table II presents the data concerning the occurrence and distribution of the Bucculatrix pupæ on 32 closely scrutinized plants. These plants were pulled at random from a heavily infested field which averaged 16 inches in height. The examination was made August 8, and the results contained in the following table also afford a very good idea of the degree of infestation at that time.

Table II. Occurrence of Pupal Cocoons of *Bucculatrix thurberiella* on Plants

Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Aver.
Cocoons on stem	5	15	6	16	[illegible]	11	4	[illegible]	1	5	7	7	5	[illegible]	4	4	4	11	10	4	10	12	7	5	5	8	23	6	7	9	7	5	7.6
Cocoons on petioles	2	1	0	2	1	0	0	1	0	1	1	0	0	0	0	0	0	3	1	0	2	1	0	1	0	0	6	5	0	0	1	1	.94
Cocoons on leaves	0	0	0	0	1	0	2	1	0	0	0	0	0	0	1	1	1	0	3	3	3	3	1	0	0	0	3	0	1	0	0	0	.72
Total	7	16	6	18	9	11	[illegible]	8	1	6	8	7	7	8	5	5	[illegible]	14	14	7	15	16	8	6	5	8	32	11	8	9	8	6	9.4

In constructing the cocoon each end is woven to a point near the middle, whereupon the larva withdraws into one half of the cocoon and deftly spins a few tie-fibrils between the ends of the opposed flutings; the gap is then entirely closed with a mesh of cross-fibrils. From the pupal records of a large series of bred individuals we find that the average duration of the pupal period for June and July at El Centro is 5.7 days. The development of the cotton leaf-perforator may be summarized, then, as follows:

	Days
Egg stage	1 (plus)
Leaf-mining stage	3
First molt	1
Second larval instar	1.5
Second molt	1.1
Third larval instar	1.9
Pupal period	5.7
Total	15.2

It is very likely that under the most favorable conditions the completion of one generation requires little in excess of two weeks.

Parasitism

At least two species of chalcidid flies have been bred from the Bucculatrix pupæ. Twenty cocoons were collected in the field during the last of June and kept under observation in the laboratory. Of these, 16 gave issue to parasites, thus yielding a computed parasitism of 80 per cent. Many larvæ of the first instar were also being killed at that time by a parasite which attacks them while in the leaf mines. Although we have observed a high mortality among individuals of the mining stage, we have been unable to breed perfect adults from such material. During August, again, the parasitism of the cotton leaf-perforator became heavy. No specific determinations of the parasites have yet been made.

Origin of Pest

The question has arisen in the writer's mind whether Thurberia or cotton (Gossypium) is the original native host of *Bucculatrix thurberiella*. Domestic and wild cotton were planted in the garden of the Bureau's station at El Centro and germinated at the same time. Thus, plants of the two malvaceous genera, of the same age and condition, were present side by side at the time of the appearance of the cotton leaf-perforator. It seems significant that the Gossypium plants early became heavily infested, while the Thurberia plants (growing immediately adjacent) remained entirely free for weeks. Furthermore, as previously stated, no cotton field in the valley has been found free from the Bucculatrix during June, July and August, which condition is also significant.

If Thurberia is the native host of the tineid pest one would naturally expect to find this plant occurring in its usual mountainous environment bordering the Valley. Since the prevailing winds at the time of the first appearance of the insect are from the west, it would be natural to suppose that the migrating individuals originally came from wild cotton occurring in the mountains bordering the Valley on the west—provided Thurberia is the native host of the species. With this possibility in view several trips have been taken into the mountains above mentioned, and a very careful search conducted in an effort to establish the occurrence there of wild cotton. Many favorable places were visited at elevations between 2,000 and 4,000 feet, but no trace of Thurberia could be found. In addition, botanists have not recorded the species from any California point.

Finally, one point in the biology of the Bucculatrix species is very suggestive. We have reference to the stockade of bristles which are

always placed by the mature larva around the cocoon site. To the finest imaginable detail these bristles exactly simulate the hirsute pubescence to be found on the stems and petioles of most cultivated cotton varieties. In length, color, general shape and even in the barbellate character of the hairs the similarity is complete. On the other hand, the Thurberia plant is of an almost glabrous nature, and the sparse pubescence which at times is found on the stems bears no similarity to the stockade bristles of the Bucculatrix cocoon. If, as they doubtless are, these protective hairs are intended to imitate the pubescence of the native host, the Thurberia plant—by this test—should at once be eliminated.

From the foregoing arguments it seems very probable that the Bucculatrix under discussion was originally a native pest of Gossypium species. If this is true it follows that the insect has found its way to the United States from the ancient cotton-growing areas of Mexico and from the insular and maritime regions of tropical America to which cotton is indigenous. In this respect is would constitute a case somewhat parallel to that of the cotton leaf worm (*Alabama argillacea*).

Explanation of Plates 36 and 37

Fig. 1. Severe infestation of *Bucculatrix thurberiella* on young, backward cotton. (Cocoons on stems indicated by arrows.)

Fig. 2. Perforating effect of the pest on the apical foliage of tall cotton.

Fig. 3. Pupal cocoon of *Bucculatrix thurberiella* on stem of cotton plant. ×10.

Fig. 4. 15-inch cotton plant showing perforations and dessication resulting from the work of larvae of *Bucculatrix thurberiella*.

Fig. 5. A 10-inch seedling cotton plant which has been severely injured and retarded by tbe presence of Bucculatrix larvae.

The Hyperparasitic Chalcidoid Planidium on Aphides. October 13, 1915, the writer collected a male specimen of *Aphis pomi* DeG. on an apple tree in the orchard of the Virginia Agricultural Experiment Station, Blacksburg. The specimen was found to possess what appeared to be a supernumerary appendage in the form of a cone-shaped, segmented body or structure which arose from the head, at the base of one of the antennæ. On the supposition that this body might be a parasite, the specimen was sent to Prof. Roland Thaxter of Harvard University, although it did not appear to be of a fungous nature, for examination, with the request that he forward it to Prof. W. M. Wheeler of Bussey Institution, Forest Hills, Mass., with whom the writer had had some correspondence regarding the significance of the body, in case he did not find it to be a fungous parasite. The specimen was forwarded by Professor Thaxter to Dr. Wheeler who identified the body as the first larval stage, or planidium, of a Chalcidoid hymenopteron, the type of larva which was discovered by him on ant larvæ in Texas. (See *Bul. Am. Mus. Nat. Hist.*, Vol. 23, Art. I, 1907; also "The Chalcidoid Genus Perilampus, etc.," by Harry S. Smith, Tech. Ser., No. 19, Pt. IV., U. S. Dept. of Agr., 1912.)

The occurrence of such larvæ on Aphides seems not to have been reported before

M. T. Smulyan, *Virginia Agricultural Experiment Station*

2

1

3

Work of *Bucculatrix thurberiella*

4

5

Work of *Bucculatrix thurberiella*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving, may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS

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It is a pleasure to record the completion of the "Index to American Economic Entomology," covering the important literature from January 1, 1905, to December 31, 1914, so far as the preparation of the manuscript is concerned. The compiler, Dr. Nathan Banks of the United States Bureau of Entomology, is to be congratulated upon having finished his part of the work, an undertaking which makes all economic entomologists his debtors. Thanks are due Dr. L. O. Howard, chief of the Bureau, for detailing the assistance necessary for the prompt completion of this work.

The "Index" contains over 25,000 references, a striking testimony to entomological industry during the decade covered by the publication. Some idea of what this means is indicated by the approximately 500 references to *Aspidiotus perniciosus*, 400 to *Carpocapsa pomonella*, 350 to *Anthonomus grandis*, 200 each to *Euproctis chrysorrhœa*, *Porthetria dispar* and *Musca domestica;* 175 to *Conotrachelus nenuphar;* 100 each to *Heliothis obsoleta*, *Hemerocampa leucostigma*, *Leptinotarsa duodecimlineata*, *Mayetiola destructor* and others.

Many familiar names are followed by fifty or sixty references while hosts of others, some decidedly unfamiliar, are accompanied by a few to a dozen citations culled from every imaginable publication. It is a guide to the latest and best in economic literature and is indispensible to every worker who would keep abreast of the times.

Obituary

GEORGE B. KING

George B. King was born in Lowell in 1848 and died July 24, 1916, at Lawrence, Mass. He was of Scotch descent and, though having only such an education as could be obtained in the public schools of his native city, his interest in nature was so great that, unaided, he took up and mastered many subjects of higher grade. For a time he was a painter by trade, but during the last thirty years of his life was janitor of the Court House at Lawrence.

His first interest in nature took the form of collecting and studying Indian relics. Later he turned to entomology and finally restricted his attention to the study of scale insects. Finding it necessary to this work he took up and mastered several foreign languages, and established a wide correspondence with other students of scale insects both in this country and abroad. His enthusiasm was great and he often worked at his office until very late at night, his hope being to prepare a book on scale insects for publication. Unfortunately his death prevented the preparation of more than a few pages of this work.

He left a widow and five children. His collections have been purchased by the Massachusetts Agricultural College. H. T. F.

TWENTY-NINTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The twenty-ninth annual meeting of the American Association of Economic Entomologists will be held in New York City, December 28 to December 30, 1916, under the presidency of Dr. C. Gordon Hewitt. The session will open on Thursday, December 28, at 10 a. m., and will be continued during the afternoon of that day. At 8 p. m., the meeting of the Section on Apiary Inspection will be held. On Friday, December 29, 10 a. m., the session of the general Association will be held. The afternoon and evening of that day will be devoted to meetings of the section on Horticultural Inspection. On Saturday, December 30, the final session of the Association will be held and the meeting will be adjourned at noon on that date unless a lengthy program necessitates holding an afternoon session.

Arrangements have been made for the meeting of the Entomological Society of America to be held on Tuesday and Wednesday, December 26 and 27. The public address will be on Wednesday evening. A notice will be sent to members giving further details concerning the meeting and all are urged to make early hotel reservations in order that there may be no difficulty in securing satisfactory accommodations for the members.

Members desiring to present papers should forward the titles promptly so that the program can be made up and printed in the next issue of the Journal. Application for membership blanks can be secured from the secretary or from Prof. W. C. O'Kane, Durham, N. H., chairman of the membership committee. A. F. Burgess,

Secretary.

Current Notes

Conducted by the Associate Editor

A new building, being erected at the citrus substation, Riverside, Cal., will contain a lecture room and laboratories for entomology.

Prof. T. D. A. Cockerell visited the National Museum for a few days during August to examine the bees of the Pergande collection.

Dr. L. O. Howard has been made chairman, and Dr. W. D. Hunter a member of the subcommittee of entomology of the National Committee for the study of malaria.

Mr. A. H. Ritchie, until recently entomologist in the Department of Agriculture in Jamaica, is now engaged in entomological work for the sugar planters' association of Jamaica.

Mr. C. H. Hadley, Jr., investigator in entomology in Cornell University, has recently been appointed extension entomologist at Pennsylvania State College, State College, Pa.

According to the *Review of Applied Entomology*, Professor H. Maxwell Lefroy was on special duty in Mesopotamia during July and August, in connection with fly investigations.

Messrs. A. J. Grove and L. Harrison have been appointed by the British War Office to advise on entomological problems in connection with the military operations in Mesopotamia.

At a conference regarding the white pine-currant blister rust at Crawford Notch, New Hampshire, September 7, Dr. L. O. Howard, Mr. A. F. Burgess and Prof. W. C. O'Kane were present.

Prof. J. G. Sanders has recently resigned as state entomologist of Wisconsin to accept the appointment as economic zoölogist of Pennsylvania. His work at Harrisburg began September 16.

Dr. James W. Chapman, formerly of the Bussey Institution of Harvard University, is now at Siliman Institute, Dumaguete, Philippine Islands, where he will be engaged in teaching and other entomological work.

Mr. Patricio Cardin, entomologist of the Estacion Experimental Agronomica, has recently been appointed by the president one of the three members of the Commision de Sanidad Vegetal recently established in Cuba.

Prof. H. A. Ballou, entomologist on the staff of the West India Department of Agriculture, visited Washington on July 21, en route to Egypt where he will be engaged for a year in the study of *Gelechia gossypiella.*

Dr. William Morton Wheeler of the Bussey Institution spent some time in Washington during August looking over the ants of the Pergande collection which has been donated to the National Museum by Miss Pergande.

According to the *Review of Applied Entomology*, the services of Dr. W. A. Lamborn have been lent by the British Imperial Bureau of Entomology to the War Office and he is now attached to the Expeditionary Force in East Africa.

Dr. S. B. Fracker has been appointed acting state entomologist of Wisconsin by the commissioner of agriculture, and will have charge of the work of the state entomologist's office until a successor to Professor Sanders is appointed.

Mr. C. B. Williams, formerly a Carnegie entomological student sent to the United States from Great Britain, has accepted an appointment from the Board of Agriculture, Trinidad, to study the parasites of the sugar-cane froghopper there.

According to *Science*, it has been planned to erect on the campus of his alma mater, the University of Virginia, a memorial to the late Maj. Walter Reed of the United States Army, who demonstrated the transmission of yellow fever by mosquitoes.

According to the *Review of Applied Entomology*, second lieutenant R. A. F. Eminson, King's Royal Rifle Corps, who recently made important investigations on the bionomics of *Glossina morsitans* in Northern Rhodesia, has been killed in action.

Prof. Charles T. Brues, Bussey Institution, Forest Hills, Mass., has been engaged temporarily as entomologist to the Health Department of New York City, to study the insects possibly responsible for the transmission of infantile paralysis in the recent outbreak in New York City.

Mr. W. F. Fiske arrived in Washington on August 10. He expects to spend about two months in the country and then return to England. The Imperial Bureau of Entomology contemplates resuming the work on the bionomics of tsetse flies in Africa immediately after the war.

An error regarding the appointments of Prof. David D. Whitney and Homer B. Latimer occurs on page 446 of the August issue of this JOURNAL. It should read that they have been appointed professor and assistant professor, respectively, of zoölogy in the University of Nebraska.

Dr. M. C. Tanquary, assistant professor of Entomology, Kansas State Agricultural College, who was granted a leave of absence in 1913 to accompany the Crocker Land Expedition, has returned to the Kansas Agricultural College and will continue his work in the college and experiment station.

At the Agricultural Experiment Station, New Haven, Conn., an outdoor insectary 10′ x 16′, covered with wire netting and provided with a temporary roof of canvas which can be rolled up, was constructed, early in the summer, for work with the pine sawfly, *Diprion simile* Hartig, and other insects.

The following entomological workers have recently left the employ of the Bureau of Entomology: William B. Middleton, resigned to study entomology at Cornell University; Ray B. Ellis and C. Joseph Manter, Hayward, Cal., appointments expired; Charles E. Smith, Baton Rouge, La., resigned.

Dr. L. O. Howard, chief of the Bureau of Entomology, and Prof. D. F. Marvin, chief of the Weather Bureau, have been appointed by the Secretary of Agriculture to represent the United States Department of Agriculture on the Council of Research which is now being organized by the National Academy of Sciences.

Additional Edibility Tests of Insect Larvæ: In the Bureau of Entomology, Mr V. A. Roberts cooked some larvæ of the squash borer, *Melittia satyriniformis* Hubn.; this dish was sampled by Dr. Howard, and Messrs. Roberts, O'Leary, Duckett, Jacobs and White, all pronouncing it good. Mr. E. H. Gibson has made similar tests of the larvæ of *Plathypena scabra*.

Mr. Arthur N. Rosenfeld, director of the Tucumán Agricultural Experiment Station, Argentine Republic, has recently resigned to take charge of the 25000-acre cane fields of Hileret & Company, Ltd., the largest sugar factory in South America. This firm maintains a private experiment station. Mr. Rosenfeld's address is Santa Ana, Provincia de Tucumán, Republica Argentina.

Recent appointments in the Maryland State College of Agriculture and the Maryland Experiment Station include Mr. C. J. Pierson, assistant in the Department of Entomology and Zoölogy in the college, who will devote his time to teaching; Mr. O. I. Snapp, Fellow in insect investigations in the college and station; Dr. Philip Garman, assistant entomologist in the station, and K. W. Babcock, student assistant in entomology.

Mr. Ignaz Matausch, a member of the New York Entomological Society, and an artist and modeler on the staff of the American Museum of Natural History, died December 14, 1915, at the age of 47. Mr. Matausch constructed many of the large models of insects exhibited in the Hall of Public Health in the museum; he also worked out the life histories of several species of Membracidæ and published eight papers on this family in the *Journal of the New York Entomological Society.*

In the Bureau of Entomology the following transfers have been made as regards locations: R. S. Woglum, Pasadena to Alhambra, Cal.; F. L. McDonough, Quincy. Fla., to Clarksville, Tenn.; W. H. Larrimer, Missoula, Mont., to Charleston, Mo.; A. B. Gahan, College Park, Md., to Berwyn, Md.; R. J. Kewley, College Park, Md., to Columbia, S. C.; W. H. Willis, Boston, Mass., to Newark, N. J.; D. G. Tower, Newark, N. J., and H. L. Sanford, to Brooklyn, N. Y.; J. L. Webb to study horse flies in Nevada and other western states.

Recent appointments to the Bureau of Entomology are as follows: G. M. Anderson and A. J. Flebut, assigned to the laboratory at Tallulah, La.; V. G. Stevens, Walnut Creek, Cal.; Dr. P. A. Boncquet, Southern California, and Prof. H. F. Wilson, Madison, Wis., collaborators; Scott C. Lyon, Oakley M. Shelby, A. D. Bosley, Samuel F. Grubs, Carl A. Wickland, D. M. Rogers, Joe Milam, Kenneth B. McKinney, F. G. Sorrells, Richard K. Catlett, Walter C. Nagle, Louis A. Stearns, L. S. Hale and Edmund H. Vance, temporary field agents in tobacco insect investigations.

A recent visitor at the Drummond Laboratory of the Bureau of Entomology was Mr. C. Hanslope Bocock, assigned by the British Board of Agriculture to study diseases of adult bees in the United States. The so-called "Isle-of-Wight" disease, or Microsporidiosis, is reported to have caused extensive losses in Great Britain, and the object of this investigation is to learn something of the diseases of adult bees in America and throw some light on the conditions observed abroad. Mr. Bocock spent a month recently with Dr. Burton N. Gates, Massachusetts Agricultural College, Amherst, and will visit other parts of the United States.

A conference was held at the office of the health commissioner of New York City, August 10, at 2 o'clock p. m., to plan an entomological survey with particular reference to the fly problem as a possible means of transmission of infantile paralysis (Poliomyelitis) in New York City and vicinity. Those attending the conference were as follows: Dr. Haven Emerson, Health Commissioner, New York; Dr. W. H. Frost and Dr. Freeman of the United States Public Health Service; Dr. M. B. Mitzmain, entomologist of the United States Public Health Service; Dr. E. P. Felt, state entomologist, Albany, N. Y.; Dr. T. J. Headlee, state entomologist, and C. H. Richardson, assistant, New Brunswick, N. J.; Prof. Charles T. Brues, Bussey Institution, Forest Hills, Mass.; Dr. W. E. Britton, state entomologist, New Haven, Conn.

The appropriation bill for 1917, which took effect on August 11, carries a total for the Bureau of Entomology of $868,880, an increase of $38,980 over the amount appropriated for the fiscal year 1916. The increase is distributed over a number of lines of work, among them the grape berry-moth, insects transmitting diseases of cucumbers, tobacco insects, clover insects in the Northwest, extension work in apiculture, and live stock pests in the West. Thirty-four clerical and subclerical positions throughout the Bureau are placed on the statutory roll, and provision is made for the payment for medical supplies and service for the immediate relief of foremen, scouts, laborers and other employees injured while engaged in hazardous work in the prevention of the spread of moths. This provision is similar to one applying to the Forest Service which has been in operation for several years.

The Governor of Minnesota has allowed an emergency appropriation for the use of the State Entomologist for fighting White Pine Blister Rust in Minnesota, with the implied promise that more money will be available if necessary. The work has been pushed vigorously during the summer. Only two localities have been found in which the rust exists, and most vigorous methods of eradication are being pushed at these places. Nurseries of the state have been combed for other evidences of the disease, but it is believed that the two localities mentioned are the only places involved at the present time.

The Plant Pathology Division of the Minnesota Experiment Station is coöperating in an advisory capacity in this work, as well as the Bureau of Plant Industry, which is also aiding the work financially. Federal Inspector Pierce has made several trips to the state and taken part in various conferences. The Entomologist has had four to eight men in the field most of the time. One infection has been traced as coming directly from Wisconsin, which state received diseased trees from Germany. The source of infestation in the second locality where the disease was found, is believed to have been an European nursery whose locality is not yet known.

Cylas Formicarius Fabr. in Flight. While riding on a street car at night between Rio Piedras and San Juan, P. R., I was interested by noticing several beetles that were flying around inside the car, evidently attracted by the light. On catching one of them I was surprised to find that it was a specimen of the sweet potato weevil, *Cylas formicarius* Fabr., which was supposed to have little or no power of flight. The place where this specimen was taken was at least a good half mile from the nearest patch of sweet potatoes, so in Porto Rico, at least, this beetle has developed strong powers of flight and doubtless spreads itself in this way. This species has also been observed to fly into houses at night to the light in Rio Piedras.

Richard T. Cotton,
Assistant Entomologist, Rio Piedras, P. R.

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A CODLING MOTH TRAP[1]

By E. H. Siegler, *Entomological Assistant, Deciduous Fruit Insect Investigations*

The control of the codling moth (*Carpocapsa pomonella* L.) in the Grand Valley of Colorado has been the most difficult insect problem with which the fruit-grower has had to contend. Time and again, despite five to eight thorough spray applications, a large percentage of the apple crop has annually been destroyed by this pest. The gravity of the situation is increased by the fact that no improvement has been made during the past decade. Furthermore, spraying has become relatively too expensive for the benefits derived therefrom, and it is quite probable that, unless some auxiliary methods are employed, the situation will remain unchanged. The theory that, on a given tree, the spray will as readily destroy one thousand larvæ as one hundred is neither logical nor true from a practical viewpoint. Spraying loses much of its profitable effectiveness wherever the worms have not been reduced to comparatively small numbers. Especially is this true under the favorable codling moth conditions of a semi-arid region.

The difficulty of controlling this insect was fully realized by the writer last season, while engaged in deciduous fruit insect investigations under the direction of Dr. A. L. Quaintance of the U. S. Bureau of Entomology and in coöperation with the Colorado Agricultural Experiment Station. After a rather brief experience with the relative abundance of the codling moth in this district, it was at once apparent that some method of control, supplementary to spraying, must be employed to reduce the number of this pest to a point where spraying would again become effective at a reasonable cost.

The purpose of this article is not to enumerate the causes which contribute to the wormy orchard conditions, but rather to call attention to a possible means of relief.

[1] Published by permission of the Secretary of Agriculture.

During the progress of the codling moth investigations, it was learned that the more successful growers have resorted to a combination of spraying and banding. The value of the latter has been generally conceded, but, at the same time, the majority of the fruit-growers have declined to make use of the bands owing to the labor and expense involved. This is due to the fact that the larvæ must be gathered about eight times each season, including the spring collection of overwintering individuals. The number taken beneath the bands, however, usually pays well for the trouble of collecting the insects. In connection with some experimental work last season, over four thousand larvæ were secured from twenty banded trees in an orchard which received six spray applications. These figures are not exceptional, but tend to emphasize the importance of banding until the codling moth can be reduced so that a reasonable number of spray treatments will hold it in check.

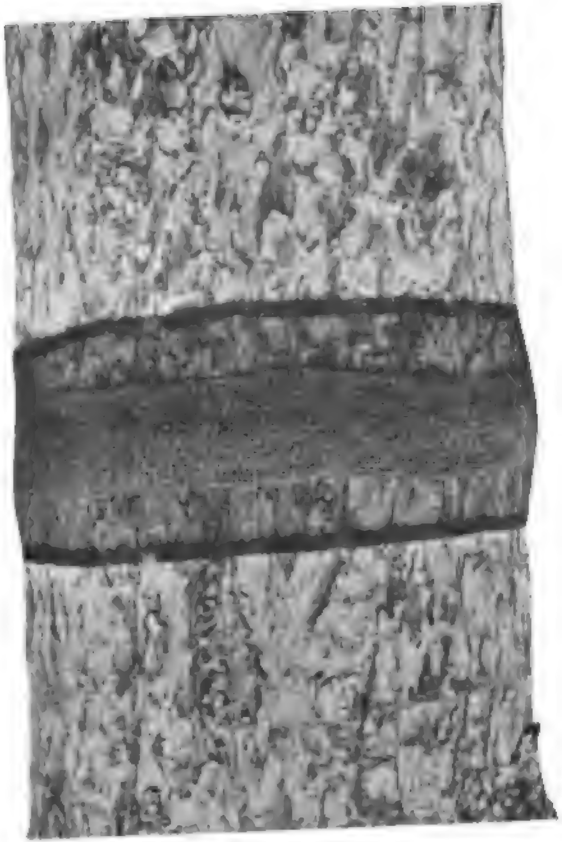
With these facts in mind, the writer conceived the idea of capturing the codling moth larvæ, without extra labor on the part of the fruit-grower, by means of a trap. The present paper is essentially a preliminary report on this device. Since its conception and operation, it was learned that a similar scheme had been proposed by C. W. Woodworth and Geo. E. Colby.[1] But whether or not a trap, such as is herein described, has ever been employed by these authors is not specifically mentioned in their publication.

The principle of the trap is a simple one taking advantage of the fact that the codling moth larva will enter an opening through which, after its transformation, the adult cannot escape.

The trap consists of a strip of twelve mesh wire screen cloth six inches wide and sufficiently long to encircle the trunk of the tree. Black painted wire cloth, owing to its dark color, is preferable. The edges of the wire screen are crimped so as to afford an elastic cushion helpful when attaching to the tree and also to prevent the screen from tearing when being stretched into place. The tree should first be banded in the usual way with burlap, or some other suitable material, folded once or twice to a width of about two inches. The strip of wire screen is next placed directly over the cloth band and is attached to the tree at one end by a couple of tacks. By means of pliers, the screen should be stretched tightly around the tree and at the same time the crimped edges should be tapped with a hammer until form fitting. Wherever the edges of the trap do not come in close contact with the tree, as in the case of a groove, a tack should be used. If the loose bark of the trunk has been removed, as is essential for the best results, the matter of adjusting the trap is a simple one.

The codling moth trap is shown in Plate 38, figure 1. A tree having a groove was purposely used to show how the trap may be made

[1] Bul. 126, Calif. Agr. Exp. Sta., 1899.



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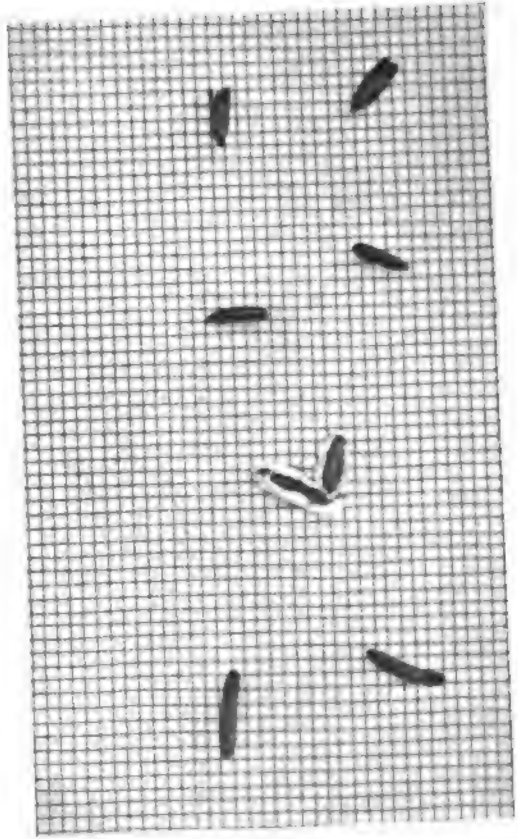

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to conform to irregular trees by means of a few tacks. The average size of the codling moth larvæ, cocoons, pupæ and adults compared with twelve mesh wire screen cloth is shown in Plate 38, figure 2.

Field Experiments with the Trap

During the season of 1915, a few preliminary experiments were made to test the principle upon which the trap was founded. Beyond proving that the device had potential value, nothing further of experimental import was done. But during the present year, a series of experiments has been inaugurated to determine the efficiency of the trap. The preliminary experiments were, therefore, planned with the view to discover how readily the larvæ are lured into the trap. To obtain such data, it was arranged to give the larvæ the option of entering the trap or beneath the ordinary cloth band. Naturally, it might be well anticipated that the larvæ would seek a place of refuge along the lines of least resistance consistent with the assurance of proper protection. The writer reasoned that if any of the larvæ should voluntarily select the trap in place of the band that the former would not be considered an undesirable cocooning place. From this, it was further deduced, that with nothing other than the trap on the tree, that the larvæ would then naturally be enticed into it.

Eight trees in a sprayed orchard were selected and each of these were finally banded with cloth half way around the trunk. At the same time the corresponding half of the trees was covered with a trap. Hence, all larvæ seeking a place in which to spin up were free to choose between the band and the trap. The following tabulated data give the first results obtained:

Experimental Results with the Codling Moth Trap, Grand Junction, Colo., 1916

Tree No.	Experiment Started	Date of Observation										Total No. of Insects	
		July 5		July 14		July 17		July 20		July 28			
		Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	In Traps	Beneath Bands
1	July 1	2	4	10	19	5	8	3	14	17	25	37	70
2	July 1	1	5	9	10	3	2	0	2	14	8	27	27
3	July 14					6	8	9	10	27	23	42	41
4	July 14					4	5	8	5	4	13	16	23
5	July 17							1	4	9	21	10	25
6	July 17							2	5	16	11	18	16
7	July 17							0	2	3	21	3	23
8	July 17							3	10	13	8	16	18
Total		3	9	19	29	18	23	26	52	103	130	169	243

Insects captured include larvæ and pupæ.

From the above figures it will be noted that 41 per cent of the larvæ voluntarily cocooned within the traps. This percentage far surpassed expectations. It will be further noted, by a study of the table, that the number of insects caught by the traps sometimes exceeded the number found beneath the bands; also, that the comparative number of insects within the trap and beneath the band on the same tree would occasionally alternate with the different observations. Improvements with the traps have recently been made, but not perfected, which may induce a still higher percentage of the larvæ to enter the traps in preference to the cloth bands.

As further evidence of the value of the traps the following data are offered: Two traps placed July 1 on trees within the same orchard were removed July 28. The total number of insects trapped including larvæ, pupæ and moths was 98—of this number 12 were in the adult stage, 11 of which were dead. Another trap placed July 5 and examined July 28 showed a capture of 43 larvæ and pupæ. Thus, in less than a month, three traps captured 141 insects in an orchard which had already been sprayed four times. Assuming that about one half of these were females, and that each would lay 50 eggs, it will be seen that the infestation on three trees has at once been reduced by 3,500 larvæ.

Some Advantages of the Trap

The cost of the wire cloth is insignificant when compared with the service rendered. Current wholesale prices average about $1.40 per hundred square feet. The wire cloth for bearing trees will therefore cost about 1½ to 2 cents per trap depending upon size. In addition to this something must be allowed for making and attaching, but this can well be done during the winter months.

Once the traps are properly applied, they should require little or no attention except at the beginning of each year. The gradual increase in the size of the tree and the elasticity of the wire screen should serve to hold the trap snugly in place. The durability of the traps has not been tested but they will doubtless not need renewal more than once every two to three years.

The use of the traps will eliminate the overlooking of larvæ and pupæ which frequently happens when the bands are used. Likewise, no moths will escape from the traps, as is commonly the case with the bands, because the fruit-grower, due to the pressure of other duties, was unable to "work the bands" on time.

One of the desirable features of the trap is that it will serve as a guide for timing the spray applications. By observing the time of emergence of the spring brood moths, the fruit-grower can figure approximately when the first cover spray for the fruit should be applied.

Throughout the season the emergence of the moths within the traps will have significance.

The time saved, during the busy growing season, by the usage of the trap, instead of the destruction of the insects beneath the band by hand, is one of the most important advantages of this device.

It is believed that the solution of the codling moth problem in the Grand Valley may be solved by a concerted movement against the first brood. The success of this action, it is hoped, will be effected by thorough and timely spraying supplemented with the codling moth trap.

Explanation of Plate 38

Fig. 1. Codling moth trap.

Fig. 2. Codling moth larvæ, pupæ and adults in comparison with twelve mesh wire screen cloth.

LIFE-HISTORY OF THE VELVET-BEAN CATERPILLAR (ANTICARSIA GEMMATILIS HÜBNER)

By J. R. Watson, *Gainesville, Fla.*

Velvet-beans (*Stizolobium* sp.) are among the most important forage and soil-improving legumes of Florida and are more or less extensively planted in the other gulf states. They are commonly grown on newly cleared land, where they are of service in choking out sprouts and other wild growth, and in cornfields, where they serve as a late summer cover crop, taking possession of the ground and climbing over the stalks after the corn matures in July or early August. They make a slow growth until after the summer rains set in, in June or July, after which they grow rapidly, a single vine sometimes reaching a length of forty feet. The presence of the bushes or cornstalks increases the yield of seed, as more pods set when the blossom racemes are kept off the ground. The vines and immature pods are killed by even a slight touch of frost. The dried pods will hang on the vines without shedding their seeds for weeks or months, the time depending upon the species or variety, and are used as winter forage for stock. The leaves and stems decay and add much humus to the soil.

Except a more or less regular toll levied by grasshoppers, the only serious insect enemy of the plant in Florida and southern Georgia is the larva of this noctuid moth. It presents somewhat of a problem as the larva is a voracious feeder and velvet-beans are very easily injured by arsenic compounds. The maximum dose that they will stand is about twelve ounces of powdered lead arsenate, together with the milk from a pound of lime, to fifty gallons of water. Even then

there will be some scorching of the older leaves. The younger leaves are not so easily injured.

The moths make their appearance about Gainesville near the middle of August and the larvæ are often abundant by the first of September. They strip the blades from the leaves, leaving only the stems and petioles. This attack, coming as it usually does at the blossoming period, often results in a total loss of seed and hence of the entire value of the plant as a forage crop. Even its value as a producer of humus is also lessened as the plant normally makes much of its growth after that date.

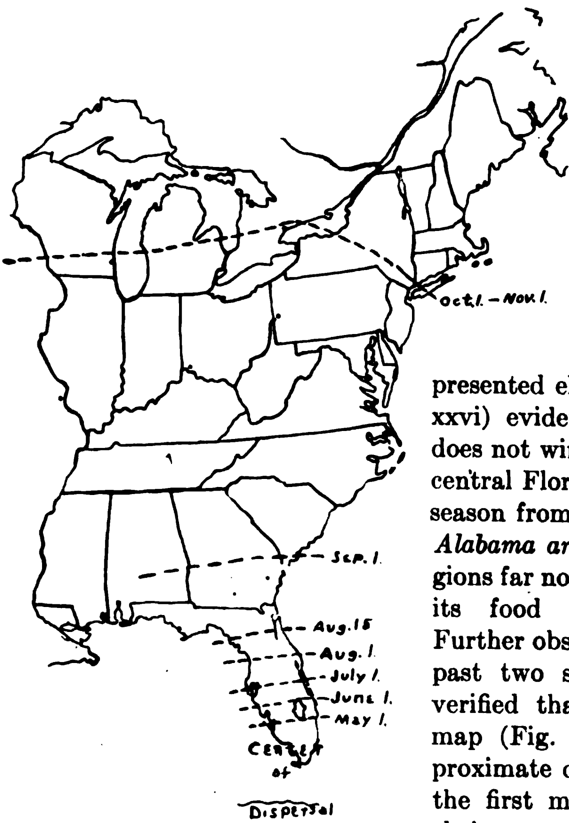


Fig. 36. Map showing annual flight of *Anticarsia gemmatilis*. (Original.)

Distribution.—The writer has presented elsewhere (*Ent. News*, xxvi) evidence that the insect does not winter over in north or central Florida but flies up each season from the south and, like *Alabama argillacea*, flies to regions far north of those in which its food plants are found. Further observations during the past two seasons have amply verified that conclusion. The map (Fig. 36) shows the approximate date of the arrival of the first moths in any part of their range. The last moths of the 1915 caterpillars were caught at Gainesville on January 29, 1916. At Jesup, Ga., the caterpillars sometimes defoliate the velvet-beans. At Valdosta and Hilton, Ga., they are known but are not considered as being of much importance. I have been unable to find any record of the caterpillars being seen north of those places. Neither do they seem to be known in the west gulf states although velvet-beans are quite extensively grown there.

Life-History.—The eggs are laid singly, mostly on the under side of the leaves, although many are found on the upper surfaces and some

on the petioles and stems. The egg is nearly 2 mm. in diameter and somewhat less in height, and flattened on its lower surface. It is prominently ribbed and white until about a day before hatching, when it turns a delicate pink. During August and September it hatches in about three days. Those laid in November required a week or more and often failed to hatch at all.

THE CATERPILLAR.—The newly hatched larva makes its first meal of the shell of the egg from which it has just emerged, leaving only that portion which is attached to the leaf. It then begins to strip the leaf of the lower epidermis and mesophyll. This is continued until near the end of the second instar when the caterpillar begins to skeletonize the leaf, eating all of the soft material but leaving the veins intact. After the second instar the caterpillar consumes the whole leaf with the possible exception of the midrib and larger veins. Larval development requires from three to four weeks in summer. There are usually six instars, but late in the season a few individuals moulted seven times.

The caterpillars are extremely variable in color and markings, especially after the second instar. At this time the majority show prominent dark-colored longitudinal lines and narrower ones of white, yellow, or pink, on a ground color of dark green. On many these longitudinal lines are dim or even entirely lacking. These individuals are usually a light yellowish green but some are mahogany brown. Only the more usual dark-colored forms are described in the following paragraphs.

FIRST INSTAR (Pl. 39, fig. 1).—The newly hatched caterpillar is about 2.5 mm. long and grows to be from 6 to 7 mm. before molting. The head is light brown in color, rounded, bilobed; mouth shining; eyes black. The body is of a uniform light green color without any trace of longitudinal stripes. The tubercles are black and conspicuous; setæ also black. The prolegs on abdominal segments 3 and 4 are about equal in size but are much smaller than those on segments 5 and 6 and are not used for walking. A glance at the prolegs is the most ready means of distinguishing the first and second instars. The legs are light brownish yellow.

The caterpillar spends about two days in this instar, the average of twenty-seven individuals being 1.7 days.

SECOND INSTAR.—The markings are now very similar to those of the next instar but are somewhat less pronounced. The most conspicuous longitudinal mark is the black border to the lateral line. The papillæ are black as in the first instar but there is around the base of each a light-colored ring. The first pair of abdominal prolegs, as in the first instar, is less than a fourth as long as the third, weak, and not used in walking or clinging; but the second pair is about half as long as the third. These, too, are ordinarily not used in walking but occasionally are so used.

The larva spends three or four days in this instar (average 3.6 days) and grows to a length of about 9 mm.

THIRD INSTAR.—Head rather square in outline, strongly bilobed, yellowish; ocelli black; mouth dark brown. Body cylindrical; all prolegs used for walking but the

first pair may be somewhat shorter than the others, light yellow; dorsal line pale white, somewhat broken, margined on each side by a darker border (Pl. 39, fig. 2). Subdorsal line very pale and indistinct, bordered as dorsal line; lateral line indistinct and broken, narrow, pale white. Sub-stigmatal line wider and continuous but of a paler color than dorsal and subdorsal. Ventral surface yellowish green. Stigmata brown. Tubercles black. These and the setæ are placed as represented in figure 37. The lettering follows Fracker's recently published plan (Ill. Biol. Monograph, vol. II, No. 1). The diagrams also show the position of the longitudinal lines.

This instar also lasts from three to four days during which time the caterpillar grows from an average of 9 mm. to 15 or 16 mm. in length.

Fourth Instar.—Dorsal, subdorsal and substigmatal lines more distinct than in the third instar. All feet used in walking but the first and to a lesser degree the second pair noticeably shorter than the others. Otherwise this instar is very like the third.

In our cages the average time spent in this instar was 3.7 days and the larvæ grew to an average length of 18 mm.

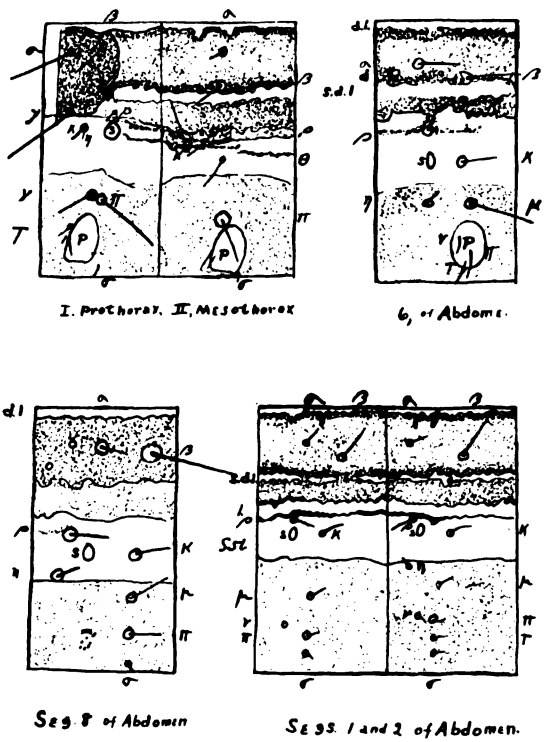
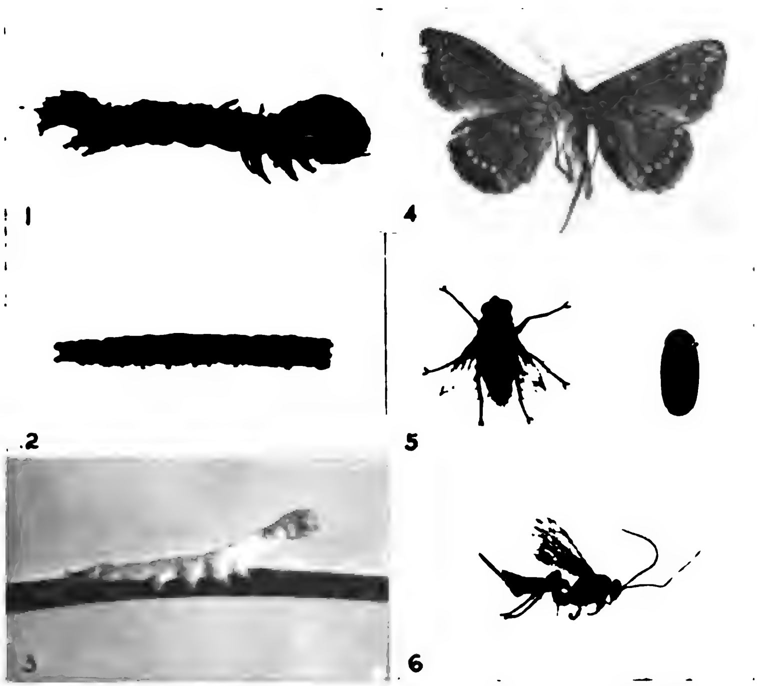


Fig. 37. *Anticarsia gemmatilis*, diagrams of representative larval segments, showing position of setæ; *d. l.*, dorsal line; *s. d. l.*, sub-dorsal line; *p.*, prolegs; *s.*, stigmatæ.

Fifth Instar (Pl. 39, fig. 2).—Also similar to the third instar but the longitudinal lines are more clearly defined. Papillæ are now white with brown apexes. In the area between the dorsal and subdorsal lines there are a few white dots with a brown border. One of the largest of these (Pl. 39, fig. 2) is situated near the anterior border and subdorsal line on abdominal segments 1–8. On the metathorax it is double. Stigmatal line is brownish yellow, broken, widely bordered with white on the ventral margin. In the lighter colored individuals this line is often a rich yellow bordered by lines of deep pink.

This instar lasts three or four days and before molting the caterpillar commonly reaches a length of 25 mm.



Anticarsia gemmatilis. 1. First stage larva. 2. Fifth instar. 3. Caterpillar killed by "cholera." 4. Ventral view of moth. 5. *Euphorocera floridensis.* 6. *Itoplectis rufuscula.*

SIXTH INSTAR.—The stigmatal line is colored like the lighter forms of the fifth instar but the pink is usually replaced by brown.

The caterpillar spends from five to twenty days in this instar, the time becoming gradually lengthened as the weather becomes cooler. The length of the full-grown larva varies from 38 to 48 mm. In the pre-pupal period it shrinks to a length of 25 mm. and turns mahogany brown with few if any signs of longitudinal lines.

PUPA.—Brown in color, smooth and shining. Abdominal segments punctuated with fine dots which are particularly thick on the anterior half of each segment. Head somewhat pointed. At the end of the abdomen are three pairs of hooked spines, one pair is much larger than the others. Length 18–20 mm., width 4–6 mm. The pupa is light green until it is about a day old.

The pupæ are usually placed barely underneath the surface of the soil, but as there are usually many dried leaves under the vines they are well hidden. They are placed in loose and frail earthen cells. In the breeding cages and sometimes in the field these cells are made of dried leaves or omitted altogether. The pupal stage averaged about seven days in August and between ten and eleven in September. As the weather became cooler this time was gradually lengthened until those that pupated in November averaged 21 days and two that pupated on November 20 and 21 respectively issued on January 7, 48 and 47 days respectively.

THE MOTH.—Like the caterpillar, the moth also is very variable (Pl. 40). The ground color varies from a light yellowish brown to ashen gray or a dark reddish brown. Old, badly rubbed individuals, are brownish yellow with the color pattern almost obliterated. Usually, however, there is at least a trace of the diagonal line remaining.

Beneath the wings are cinnamon brown with a sub-marginal row of light spots and a median dark line. This color pattern is less variable than that of the upper surface (Pl. 39, fig. 4).

Mating probably occurs at night. A single pair was observed mating in the cages. This occurred about dusk. They remained *in coitu* only a few seconds. Dusk is the period of greatest activity of the moths. During the day they lie hidden under the leaves of the host plants. If disturbed they fly a short distance only. They do not go to lights readily and on the whole it would seem that they are not in the habit of taking long flights. Doubtless, however, in the absence of the host plants of the larvæ, they are capable of long sustained flight. There is no suggestion of definite broods. The moths seem to [illegible] in numbers from the south during August and at any time after [illegible] ges in the field on the same day.

Host Plants

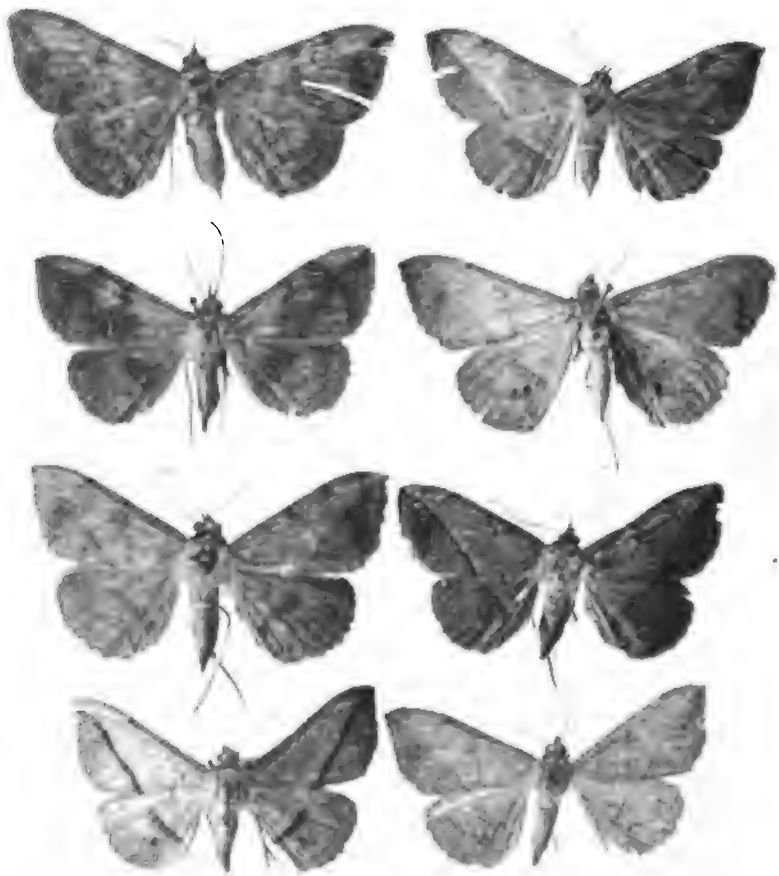
The writer has found the caterpillars feeding upon but three plants. Named in the order of preference they are: velvet-beans (*Stizolobium* sp.), kudzu vine (*Pueraria thunbergiana*), and the "horse bean" (*Cannavalia* sp.). Some varieties and species of velvet-beans are evidently preferred to others. The common "Florida velvet" is always much more severely damaged than the "China" when the two are planted side by side. As the caterpillars ordinarily do not leave the plant on which they were hatched, any choice between plants must be made by the female moths at the time of ovipositing. When leaves of the two varieties were left over night in a cage of moths there were, on the average, two eggs deposited on the "Florida velvet" to one on the "China." Care must be taken that the leaves are of equal age as the moths are less attracted to either very young or old leaves. The early maturing varieties, such as the China, have the further advantage that if they are planted early they will, at least in northern Florida, often mature most of their seed before the caterpillars become abundant.

The caterpillars feed both night and day, stopping only to molt. Some determinations were made of the amount of food they normally consume. The larvæ were well fed at the beginning of the experiment so that the amount they consumed should be not far from that usually eaten in the field. Twenty-two caterpillars in the fourth, fifth, and sixth instars weighing 4.8 grams ate 17 grams in 52 hours, an amount equal to their own weight at the beginning of the experiment in less than fifteen hours. Another lot of fifty-three larvæ weighing 8 grams ate 24.5 grams of leaves in 48 hours, the equivalent of their own weight in less than sixteen hours. No cannibalistic tendencies were observed even when the food was exhausted in cages in which many caterpillars of different sizes were confined. In this respect they differ markedly from some other Noctuids such as *Heliothis*.

Caterpillars in the first and second instars, when disturbed, lower themselves on a silken thread. But after the second instar this thread is usually not secreted. Instead the caterpillars quickly throw themselves to the ground by means of very rapid and violent contortions. The noise they make in dropping from the upper to the lower leaves as one walks through the field is quite characteristic and furnishes a ready means of detecting their presence.

Natural Enemies

The caterpillars are eagerly sought by many predaceous enemies. One of the most important is the red-winged blackbird or "Ricebird" (*Agelæus phœniceus*). These birds congregate in infested fields in



7

Anticarsia gemmatilis, variations in pattern

great flocks composed largely of immature individuals. Other birds, especially mocking-birds and field sparrows, feed eagerly upon them. The lizard Anolis ("chameleon") is also an important enemy, which is commonly seen climbing over the vines. Various species of wasps prey upon them. *Callida decora*, a small blue carabid, is common on the plants and feeds upon the eggs as well as the young larvæ. Next to the blackbirds the most important predaceous enemies are probably several species of hemiptera. *Alcæorrhynchus grandis* Dall., is probably the most abundant but *Brochymena annulata* Fab., and *Eurhyrhynchus floridensis* Linn., and *Podisus maculiventris* Say are common.

In sharp contrast to the predaceous enemies the insect is remarkably free of internal parasites. From many hundreds of pupæ collected but two parasites were raised. One (Pl. 39, fig. 5) proved to be an undescribed species of Tachinid which Townsend has named *Euphorocera floridensis* and the other an ichneumon, *Itoplectis rufuscula* Davis (Pl. 39, fig. 6).

Cholera.—By far the most efficient check on the increase of this insect is a disease of the caterpillars called "cholera" by the farmers. It is caused by a fungus, *Botrytis rileyi*. Sometime during September or early October this has always become epidemic in the fields and in a week's time all but exterminated the caterpillars, a very small fraction of one per cent escaping. After the epidemic one may have to search for an hour or more to find a single live caterpillar where a week before they had been so numerous as to strip most of the leaves from the vines.

The first symptom of the disease is the flaccid, emaciated appearance of the caterpillar. It does not feed. It soon elevates the anterior portion of the body, head, thorax and first two abdominal segments at an angle of about 45 degrees and dies in that position (Pl. 39, fig. 3). In a day or two the spores mature and the corpse turns white. Healthy caterpillars confined with these corpses become sick in three days. The fungus attacks all instars alike. Although it is usually possible to find a few of these mummies in the field at any time during the caterpillar season, it requires favorable weather conditions to start the epidemics. These conditions seem to be a prolonged and rather cool rain such as frequently occurs in late September. Perhaps the resistance of the caterpillars is lowered by the cooler weather as this is a distinctly subtropical insect. At least we have not succeeded in our attempts to start a premature epidemic. Even when the caterpillars were confined under a bell-jar in a saturated atmosphere with mummies, the disease did not become epidemic among them until "cholera time" arrived.

Although there may be a partial recovery after an epidemic, the caterpillars never again during that season become sufficiently numer-

ous to be troublesome. The fungus invariably holds the insect in check. A majority of the young caterpillars die within ten days after hatching.

Although "cholera" often arrives too late to save the crop if the farmer depends upon it alone, it is nevertheless a great help as it reduces to a few weeks the time during which the farmer needs to apply arsenicals.

SOME NOTES CONCERNING OVERWINTERING OF THE HOUSE-FLY, MUSCA DOMESTICA, AT DALLAS, TEXAS[1]

By W. E. Dove, *United States Department of Agriculture, Bureau of Entomology*

From the facts that adult house-flies are found in dormant, semi-dormant and active states in mid-winter, and possess a greater longevity during low temperatures, earlier investigators have generally assumed that the species passed the winter in the adult stage. This conclusion is further supported by the fact that numbers of inviable pupæ have been taken in nature during the early spring. The treatment of manure piles with borax and hellebore and the effectiveness of the maggot trap in control of house-flies has necessarily caused us to recognize the overwintering of *Musca domestica* as a biological point worthy of more consideration and one which should be supported by more experimental evidence.

Under the direction of Dr. W. D. Hunter, and at the suggestion of Dr. L. O. Howard, some biological points of economic importance were made a subject of study at Dallas and Uvalde, Texas. We have recorded two instances in which we succeeded in carrying the immature stages of the species over the winter in infested manure (1). Due to the fact that *Empusa muscæ* was unusually abundant and probably killed most of our adults, we did not attempt to ascertain the winter longevity. Further experiments with immature stages and with the longevity of adults are herein reported. I am gratefully indebted to Mr. F. C. Bishopp under whose direct supervision the work was done for valuable suggestions.

Adult Longevity

I wish to quote Mr. R. H. Hutchison (2), who reports that "in one hibernation experiment, in which flies were kept in a stable varying from 30° to 60° F., a few lived as long as 70 days." This experiment was conducted at a more northerly latitude than Dallas, Texas, and where temperatures are more constant.

[1] Published by permission of Chief of Bureau of Entomology.

In Table I, in which experiments no Empusa occurred, adults were not subjected to fatal temperatures, and received an abundance of food. It will be observed that the longevity was prolonged as the temperatures decreased and in once instance a fly lived for 91 days. This maximum longevity is a record obtained under the most favorable abnormal conditions which I find are not utilized by adults in nature. It is well to know the conditions under which this maximum longevity was obtained.

A room, in which a box was placed containing hundreds of pupæ in infested cow manure, was gradually heated to a maximum of 70° F. and the temperature allowed to remain about the same for thirty-six hours. During this time 600 adults emerged into a 4′ x 4′ x 5′ cage and all apparently fed soon after emerging. Ripe bananas, sweet milk, and fresh cow manure were present, and at short intervals during the longevity these were freshly replenished. No hibernation material was supplied for as near as possible the actual temperatures experienced by the adults was desired. Five days later, on December 17, the room was again gradually heated to 70° F. and allowed to remain for a short time to insure a second feeding. Great activity was manifested and apparently all again fed. The cage was located in the coldest room on the north side of a two-story frame house, and excepting the two periods of artificial heating to insure feeding of adults I believe the temperatures most favorable for a maximum longevity were obtained. Between the first and second feeding of the adults a minimum of 20° F. occurred, but was present only a few hours. During this time sixty adults died, but this was probably only an elimination of those not sufficiently fed, as will be seen from a study of effective temperatures discussed in a later paragraph. After the second feeding of the adults a minimum of 32° F. occurred on December 26, and a minimum of 28° F. on January 24, but neither of these continued long enough to greatly affect the mortality. An average of the daily minimum temperatures during the longevity period was 42.58° F., an average of the daily maximum temperatures 57.66° F., while the daily mean average was 50.12° F. The room in which this experiment was conducted was used for no other purpose, for the reason that the movement of persons and the warmth of their bodies would have increased the temperatures, thereby increasing the activity of flies. It was also partially darkened by window shades which kept out the sunlight and lessened activity. This, however, did not prevent feeding of adults during the warmer portions of the day. On some days it was warm enough to permit flight, and had the flies not been caged they would have then sought the warmer portions of the house. Being caged they were allowed to feed but were necessarily kept quiescent

during the greater portion of the time. Had they been liberated under warmer temperatures it is easy to see from the experiments cited in Table I that the longevity would have been materially reduced.

On December 8, 1914, 750 adults emerged from another portion of the same media as the experiment discussed above, were fed bananas and milk in abundance. Apparently all fed and were in good condition. They were liberated in a large covered cage in the open and in addition to the food which was ever present they were supplied with shelter consisting of boards, burlap sacks, paper, and excelsior. These were conveniently arranged to allow the adults to obtain protection with little effort. As will be observed in Table I, a minimum of 14.5° F. occurred on December 15, and there was a gradual decrease in temperatures until this degree was reached. On January 4, at a maximum of 64° F., only one adult proved to be alive and this died before January 9. These conditions, which seem to have been more favorable than those obtaining in nature, gave a maximum longevity of not more than 32 days.

From the two experiments cited above we know what longevity to expect under these temperatures and conditions. Let us now consider the questions: What are the reaction of adults in nature to temperatures, and what are the effects of these temperatures on adults?

Reactions of Adults During the Winter to Varying Temperatures

In a winter experiment to determine the longevity of adults under kitchen and restaurant conditions a number escaped from the cage and were free to visit places of various temperatures. The general tendency was to seek temperatures slightly above 60° F., which being higher than that of the caged ones caused them to die much sooner. It is true that the caged adults were always supplied with food, but bananas and peels were placed in portions of the room where escaped adults were observed to congregate. The last fly in the cage lived for 54 days, but no living flies could be found in the room and adjoining rooms after 30 days.

Observations have been made of flies rendered inactive by low temperatures but in no case have I ever observed living adults to remain quiescent for more than a few days. The natural heat of the sun or very slight artificial heat will cause them to become active.

In cases where adults were subjected to freezing temperatures they were killed, the duration of life depending upon whether or not they had previously fed. Unfed and slightly fed adults died outright, and those which were allowed to feed previously were not capable of withstanding continuous freezing temperatures for three days. Below

45° F. all adults were quiescent; fed ones crawled slightly at 48° F., could be forced to fly at 51° F. and would fly voluntarily at 53° F. When voluntary flight occurred adults would feed if food was near, but would not search for it. Efforts were made to determine the actual effective temperatures for adults. In working with specimens motionless from cold the thermometer was placed on the ground with them, and in other cases a suspended thermometer was used on which adults alighted prior to the low temperatures.

At Dallas, Texas, there is no long period of low temperatures during which adults become altogether dormant. When freezing temperatures do occur at night it is often warm enough at midday to permit activity out of doors. The cold weather usually comes in the form of "northers" and the temperature often drops 30° F. or more within twelve hours. If, prior to a norther and on a fairly warm day, one visits the city dumping grounds he will find numerous flies feeding and occasionally depositing. Garbage wagons leaving during the day will be carrying them to various portions of the city, though the number is not to be compared with the greater number during the summer months. Shortly after a norther and when outside temperatures are warm enough to permit flight, if one again visits the dumping grounds, not a living adult is to be found. Only adults in houses are found alive and they are mostly in warm places and active. The death of exposed adults under conditions as above outlined has been proved by gradually warming those which were found inactive and unprotected from cold.

In general it may be said that the longevity of adult house-flies varies indirectly with decreases in temperature provided they have sufficient food, are not subjected to freezing temperatures and are not killed by *Empusa muscæ*. Should they be prevented from following their natural tendency to seek temperatures above 60° F., the humidity being normal, the adults become inactive at 45° F. But since the temperatures vary in different places, ,either naturally or by man's interference, adults do not generally remain quiescent. They seek the warmer temperatures and their longevity is correspondingly decreased.

Possible Relation Between the Development of Empusa Muscæ and Oviposition

In the spring of 1915 a number of specimens of *Lucilia sericata*, all of which had emerged from the same infested meat, were placed in disinfected cages. Fresh bananas were supplied in all cages. In an attempt to determine the effect of a lack of deposition media on the longevity, some adults developed a fungus. This was first observed among females, but only in the cage where meat was not supplied for

TABLE I. MAXIMUM LONGEVITY OF MUSCA DOMESTICA AT DALLAS, TEXAS

Date Adults Emerged	Number	Date Last Fly Died	Greatest Longevity	Min. Temp. Occurrence	Average Daily Minimum	Max. Temp. Occurrence	Average Daily Maximum	Average Daily Mean	Food
May 16, 1914	250	June 8, 1914	23 days	51.9° F., May 17, 1914	68.37° F.	92.1° F., June 8, 1914	84.77° F.	76.57° F.	Bananas and horse manure*
June 23, 1914	100	July 18, 1914	25 days	73.1° F., June 27, 1914	75.79° F.	104° F., July 14, 1914	99.75° F.	87.77° F.	Plums, milk and horse manure*
July 9, 1914	350	July 28, 1914	19 days	70° F., July 28, 1914	74.99° F.	104° F., July 14, 1914	100.52° F.	87.75° F.	Bananas, milk and horse manure*
July 23, 1914	75	Aug. 12, 1914	20 days	70° F., July 28, 1914	74.24° F.	104.3° F., July 30, 1914	96.9° F.	85.57° F.	Peaches and cow manure*
July 27, 1914	200	Aug. 16, 1914	20 days	69.7° F., Aug. 16, 1914	73.59° F.	104.3° F., July 30, 1914	94.31° F.	83.95° F.	Canteloupe and horse manure*
Oct. 22, 1914	700	Dec. 14, 1914	53 days	16.5° F., Dec. 14, 1914	43.71° F.	86.3° F., Nov. 5, 1914	64.57° F.	54.14° F.	Milk, bananas, cow manure, horse manure*
Dec. 8, 1914	750	Jan. 9, 1915	32 days	14.5° F., Dec. 15, 1914	32.8° F.	64° F., Jan. 4, 1915	46.99° F.	39.89° F.	Bananas and milk
Dec. 10, 1914	600	Mar. 12, 1915	91 days	20° F., Dec. 13, 1914	42.58° F.	70° F., Dec. 10–13 and 17, 1914	57.66° F.	50.12° F.	Bananas and cow manure

*Copulated and deposited.

depositions. Copulations had been observed in this experiment, and by comparison with similar lots of adults it is certain that the adults were sexually matured. An authentic determination of the fungus was not obtained, but it was apparently *Empusa muscæ*.

In the experiments with *Musca domestica*, cited in Table I, no Empusa appeared. It seems possible that the fungus develops principally in sexually matured and fertilized flies which do not deposit on account of low temperatures. The fungus appears to occur among house flies only under cool conditions of autumn and the fact that they do not deposit during low temperatures may be the explanation.

Larval Stages

Winter depositions have been observed in various instances on warm days at Dallas, Texas. In Table II it will be observed that in Breeding Nos. 59, 56 and 58 freshly deposited eggs were obtained, on January 14, 1914. These were deposited by clusters of females on a manure pile which was generating heat. The eggs were divided, allowed to hatch and develop; some in the manure pile, some in a small tin box in the house, and some in a similar tin box in a shelter for weather instruments. Adults were reared from the manure pile, by preventing the larval migration, within twenty-three days from hatching and in the house in forty-nine days from hatching. While no adults were produced in the shelter, the length of the larval period was extended to twenty-five days. In the shelter the larvæ died when very small and being moist experienced lower temperatures than the air which had a minimum of 11.5° F. Similarly, in Breeding No. 57, in which small larvæ were taken from infested manure and straw, all died within thirty days. In Breeding No. 97–B, freshly hatched larvæ which were kept in a mixture of cold wet manure, to which was added occasional small lots of fresh manure, lived more than sixty-seven days.

While young larvæ are capable of withstanding conditions that will lengthen the periods as shown above, in most cases larvæ will become developed before the media becomes cold. Especially is this true in manure piles during the early portion of the winter. In Breeding No. 62, 1,400, one half to fully grown, larvæ were selected by hand and retained in the same media. This consisted of a mixture of horse manure and decaying straw which was of a cold nature, and was not placed on soil where the larvæ could penetrate for protection. Living larvæ were present on February 5, 1914, which was ninety days after they were placed in the cage. By referring to Table II, we find other instances in which larval periods were greatly extended, and while I am certain that greater periods than these were obtained, the fact that larvæ and pupæ were both present at the beginning of some experi-

ments, makes it impossible to determine the maximum length of the larval stages. To have examined the infestation would have caused abnormal conditions. However, in Breeding No. 66, in which infested manure was placed in a cage and subjected to two inundations, larvæ were present from November 26, 1913, to March 21, 1914, a period of at least 115 days. In this experiment adults emerged from the over wintering material, and has been reported in a previous paper (1.). In the experiments with larvæ which produced no adults there was no soil into which they could migrate to a depth which would be protective to their pupæ.

Pupæ During the Winter

Confining our attention to the winter pupal periods we find that where pupæ were in manure piles in which heat was generated, as in Breeding No. 99, emergence continued until all viable pupæ produced adults. In this experiment 85 adults were observed to emerge when the maximum for the twelve hours of emergence was 55° F. and the minimum 43° F. These were the actual temperatures of the media, which consisted of cow manure and some straw. At other temperatures above these emergence was most frequently observed. Only when pupæ were kept at these or warmer temperatures did they produce adults, and these emerged in a comparatively short time. The inviability of pupæ remaining unemerged in Breeding Nos. 65, 100, 99, 62 and 56, was determined by warming them during the spring. In Breeding No. 56, the emergence ceased when the box containing pupæ was removed from the manure pile, and none emerged thereafter. In Breeding No. 62, pupæ were produced by larvæ migrating into an old burlap sack which was on the bottom of the tin compartment, but on account of low temperatures none emerged.

Numerous winter and spring collections of pupæ from garbage and old manure piles in various outdoor locations, but which were taken near the surface of the soil or in the media, failed to produce adults when subjected to favorable conditions. It is evident that pupæ in such conditions either receive enough heat to produce adults during mid-winter or die from temperatures too low to permit emergence. However, pupal periods have been observed to extend for 26 days or longer, and it is reasonable to expect long periods from pupæ formed from migratory larvæ which penetrate deep enough for protection from excessive cold or warmth. It is evident from the experiment described below that larval migration is a great factor in placing pupæ at a favorable depth in the soil.

TABLE II. EXPERIMENTS IN OVER-WINTERING OF IMMATURE STAGES OF MUSCA DOMESTICA AT DALLAS, TEXAS

Breeding Number	Placed in Cage	Number	Stage of Development	Media	Additions of Fresh Uninfested Manure	Emergence From	Emergence To	Number Emerged Adults	Length of Larval Stage	Total Development
									Days	Days
59	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Horse manure in house	Jan. 20	Mar. 6 10 a. m.	Mar. 6, 6 p. m.	7	23	49
56	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Manure pile generating heat	Every few days about caged infestation	Feb. 8, a. m.	Feb. 9, a. m.	4	15	23+
58	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Horse manure in weather shelter	Jan. 20			0	25	
97-B	Nov. 23, 1914		Freshly hatched	Cold horse and cow manure	Occasional small lots			0	67+	
63	Jan. 21, 1914		Larvæ above half grown	Cow manure and straw	Jan. 29	Mar. 17	Apr. 16	27		
64	Dec. 26, 1913		Larvæ and pupæ	Cow manure in small pile				0	42+	
101	Dec. 1, 1914	1,200	Various size larvæ	Cold cow manure in tin box	None			0	73+	
62	Dec. 26, 1913	1,400	Larvæ, half to full grown	Horse manure and straw	Feb. 5			0	90+	
57	Dec. 26, 1913	600	Larvæ less than one-half grown	Horse manure and straw				0.	30–	
99	Nov. 7, 1914		Larvæ and pupæ in box	Manure pile generating heat	Every few days	Dec. 3	Jan. 12	273		
100	Dec. 1, 1914	750	Pupæ	Cold cow manure in tin box	None					
65	Dec. 30, 1913	1,000	Pupæ	Box in manure pile			Feb. 9	All viable		
105	Nov. 7, 1914	Thousands	Larvæ and pupæ	30 bushels cow manure	Until Jan. 14		June 5	142*		About six months
66	Nov. 26, 1913		Larvæ and pupæ	Horse manure, cow manure and straw	None	Nov. 27	May 26	10 or 11 *	115+	About six months

*Over-wintered.

A Normally Infested Manure Pile During the Winter

Between October 7 and November 7, 1914, about thirty bushels of cow manure, waste hay, pieces of boards, and rubbish were allowed to accumulate in a pile which, exposed in the open, became most heavily infested with larvæ and pupæ. The manure pile being warm from generated heat, the conditions were very favorable for development, and to be certain that the infestation was mostly *Musca domestica*, some eight hundred flies were separately bred out by artificial heat. Fresh uninfested cow manure was added to the cage until January 14, and during this time adult house-flies continuously emerged. Additions of fresh manure being discontinued on January 14, the generated heat gradually decreased and caused them to cease emerging by January 30. Prior to this date at least 600 adults emerged normally. With their decrease in number the predaceous *Scatophaga furcata*, as determined by Dr. J. M. Aldrich, increasingly emerged in the cage. This species has previously been pointed out to be predaceous upon adult flies and this was fully confirmed by our observations. The manure pile intentionally remained unchanged in size or form after January 14, and no emergence occurred until April 16. On May 5, three other house-flies emerged and emergence continued until June 5, during which time the total number was at least 142. I believe the emergence in the cage would have been a surprising number of hundreds had the cage been large enough to allow a margin of a few feet on either side of the manure pile to prevent escape of migrating larvæ.

The migration of larvæ has been sufficiently dealt with by Hutchison (1914 and 1915). The larval habit of burrowing into the soil has been graphically illustrated by Dr. C. G. Hewitt (1915). At Dallas, Texas, during the fall of 1914, about 900 adults were observed to emerge into an empty cage six feet from a manure pile; the greatest distance of a single larval migration was at least eight feet. The burrowing depth of the larvæ was not determined, but Dr. Hewitt's diagram shows that they have been found in sandy loam two feet deep, and good numbers were present below a depth of one foot. Attention is called also to the fact that the larvæ pupated far enough away from the manure pile so as not to be affected by the generating heat.

The cage of Breeding No. 105 contained the only accumulation of infested manure on the premises, and yet when adults began to emerge in the cage they continuously increased in number on the walls of nearby houses. It is quite evident that this was due to the larval migration from underneath the sides of the cages.

The failure in so many overwintering experiments to produce adults in spring may be attributed to the absence of soil into which the larvæ could migrate for protection.

In Breeding No. 66, the infested manure was placed in a cage and inundated during two different periods which caused fermentation to cease. This apparently rendered the condition for larvæ more like that of soil underneath a manure pile than that of pure manure. The medium was a mixture of horse manure, cow manure and straw heavily infested, and the individual cow droppings not being well broken up probably served in protecting the larvæ from drowning during the inundations.

Summary

It should be understood that all of the observations dealt with in this paper were made at Dallas, Texas.

1. Adult house-flies having sufficient food, not subjected to fatal temperatures, killed by *Empusa muscæ*, nor destroyed by predators, show increased longevity in indirect proportion to decreases in temperature.

2. The general tendency of adults to seek temperatures above 60° F. necessarily causes a shorter longevity than 91 days, which was obtained in a most favorable abnormal caged condition.

3. The humidity being normal and adults being prevented from warmer temperatures they become inactive at 45° F., crawl slightly at 48° F., and will voluntarily fly at 53° F. Even previously fed adults, if subjected to freezing temperatures, die in less than three days.

4. "Northers," causing sudden drops in temperature, are responsible for a large mortality of flies in the vicinity of Dallas, Texas, yet warm periods occur during mid-winter which permit depositing.

5. There is a possibility that epidemics of *Empusa muscæ* may be caused by a lack of deposition media for flies which are sexually matured and have copulated.

6. Breeding media ranging from 46° F. to 55° F in twelve hours will permit emergence of adults from puparia, but emergence has never been observed at lower temperatures.

7. Great numbers of pupæ near the surface of the soil receive either enough heat to permit emergence of adults which usually succumb to cold before depositing or the temperatures are so low that they become inviable.

8. Young larvæ have been kept for more than 67 days without pupating, but only by occasional additions of small amounts of fresh manure.

9. Larvæ more than one-half normal size have been kept alive for more than 90 days, and still other larvæ of various sizes have been observed to live for 115 days.

10. Adults have been observed to emerge in an empty cage six feet from a manure pile, the pupæ having been produced by migrating larvæ. The greatest larval migration was at least eight feet.

11. In a naturally accumulated and infested manure pile larvæ and pupæ were overwintered. Adults continued to emerge during mild weather in mid-winter as long as manure was added. Emergence stopped when addition of manure ceased, but in spring at least 142 adults emerged.

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SCIARA MAGGOTS INJURIOUS TO POTTED PLANTS

By H. B. Hungerford, *University of Kansas*

During the winter months of 1912 numerous complaints were received concerning a tiny black gnat that was appearing in annoying numbers in conservatory windows and around the potted plants. In nearly every case they were held accountable by the housewife for the lack of thrift of many of her plants—an opinion not shared with any degree of assurance by the writer.

Upon investigation, the gnats invariably proved to be Mycetophilid flies of the genus *Sciara*,[1] and their shiny, black-headed white maggots were to be found in the dirt of some of the potted plants—sometimes in such numbers as to be turned out of the soil in small squirming balls.

Since this was the first time that these flies had been brought to our attention in this relation, we were not only at a loss regarding means of exterminating them, but, moreover, were skeptical as to the actual damage they were doing, being more inclined to attribute the sickly

[1] *Sciara coprophila.* The writer is glad to acknowledge his indebtedness to Dr. O. A. Johannsen of Cornell University for the identification of the flies and for placing at his disposal bibliographical material.

appearance of the plants to some physiological condition of the soil or surroundings.

The meager literature dealing with Mycetophilid depredations was scanned, and recommendations for control were made accordingly. It was very shortly discovered that the remedial measures given were decidedly ineffective when applied against these maggots, and, after running the gamut of the "suggested controls," we were compelled to admit to our friends that in the present state of our knowledge, we knew no satisfactory means of control.

To prevent any future embarrassment of the kind, the writer began a series of experiments, to determine the cause for the infestations, the nature of the injury, if any, the life-history and the control.

Literature

These insects have received but little attention from the economic entomologists, if we may judge from the literature. Most of the references are mere reports of their occurrence or injury. The gregarious migratory habit of some species has been reported from many quarters. Fifteen out of some thirty-five references relating to the biology of members of this family are devoted to noting this phenomenon. While the life-histories of but few have been reported, Beling (1),[1] Bezzi (2), Girard (9), Pastejrik (17), in articles not accessible to us, have dealt with the biology of various species of the genus.[2] Chittenden (5) gives the description of the larva and pupal stages, but the eggs were unknown to him and the length of the various stages not mentioned. Coquillett (6) describes pupation of *Sciara tritici* as occurring in an oval cell lined with a few silken threads. He also noted the eggs of this species as being scattered on the ground or deposited in clusters of twenty or more. He describes the eggs as oval, polished, white, and measuring about 1/10 of a millimeter in length. The length of the various stages was not known.

[1] See Bibliography.

[2] Since writing the above I have had the opportunity to review these papers in the libraries of Cornell University. Beling (1) gathered the maggots of twenty-four species from their breeding places in decaying wood, under fallen leaves in cow dung, etc. He describes the maggots and pupæ, giving in most cases the length of the pupal stage. In three instances he mentions the eggs but does not state the length of the incubation period. Bezzi (2) describes the eggs of *S. analis* as white, oval, twice longer than broad, and with such fine punctures that they appear smooth to the naked eye. The females lay from 200 to 240 eggs in more or less numerous clumps. The incubation period is given as seven days, the larval stage a little over a month and the pupal stage a week.—This article in Italian is perhaps the most complete account of the life history of any Sciara.

Dr. Johannsen, in his excellent work on the Fungus Gnats of North America, gives the description of forty-nine species in the genus *Sciara*, thirty of which are new species described by him, and four are not assigned. A few others are named, the descriptions of which are inadequate. Of these forty-nine species, rearing notes are given for less than a dozen. *S. multiseta* Felt, *agraria* Felt and *coprophila* Lintner were taken from mushroom cellars; *S. fulvicauda* Felt and *lugens* Joh. from decaying roots and wood; *S. pauciseta* Felt from decaying potatoes; *S. Hartii* Joh. and *cucumeris* Joh. from cucumbers, while *S. tritici* Coq. larvæ are reported as feeding in wheat, and *S. sativæ* Joh. was supposed to prey upon puparia of the Hessian fly.

In the species we have studied we have often seen the larvæ, especially the young ones, feeding upon the dead bodies of adults and pupæ of their own kind, but we have not observed them devour the living.

Habits and Economic Importance

The family Mycetophilidæ, to which these flies belong, gets its name from the fact that many of them breed in fungi. The food of the maggots of most species consists of either fungi or decomposing organic matter. However, those of some species of the genus *Sciara* do, on occasion, feed upon living roots of plants. C. A. Hart[1] reports an experiment to determine the food preferences of the larvæ as follows:

> A cucumber plant was potted in clear sand and one hundred of the maggots were placed about its base. These affected the plant, the stem evidently being eaten by them. The same experiment was made with the addition, at one side of the pot, of a cubic inch of decayed horse manure, such as is mixed with earth in growing cucumbers. The larvæ were subsequently found collected about the piece of manure and the plant remained uninjured. Next, a plant was potted in a mixture of manure with earth from the forcing bed infested by maggots. The plant was not injured.

His conclusions are that injury to living plants results only where larvæ are excessively abundant. He further states that:

> In no case were the maggots found attacking a firm, healthy stalk or root of the cucumber plants, but at the least appearance of decay they attacked it in great numbers, gnawing the surface and tunneling through it in all directions.

It was our belief that such would be the case with those species we have studied. But, during the past five years, under all sorts of soils and conditions brought to bear in the flat glass root cages, we must state that it has been our observations that they will attack healthy roots even in pure, well rotted manure and in soils with the optimum amount of dried blood fertilizer. We have frequently watched them

[1] Experiment by Mr. Green recorded in 26th Report of State Entomologist of Illinois.

eating the root hairs of various rootlets and devouring sound, growing roots.[1]

Dr. Johannsen states that:

Florists look upon these little gnats with a suspicion which is more than justified, as the fact that the larvæ feed upon the tender roots of potted plants is well established.

He further states:

I have found larvæ in potatoes, feeding on the sound tissue, on the roots of various grasses, and in tulip bulbs.

The maggots of those species we have studied are almost omnivorous as to feeding habits and the injury to plants becomes apparent only when they are relatively abundant. We have watched a maggot as it devoured the dead pupa of one of its own species, nibbled at flakes of decaying organic matter and then, coming to a live healthy root of a wheat plant, proceed to devour it, following its windings for some distance, eventually eating all of the three inches of root that lay against the glass. Maggots newly hatched seem to prefer the root hairs and often clean a rootlet for some distance, and then work upon its surface.

An examination of the root system of an infested plant often shows it severely curtailed. In Plate 42, figure 6, is the photograph of a geranium where the maggots were abundant. Plate 42, figures 1 and 3 show their work upon a geranium slip.

There can be no doubt as to their injurious work.

This lack of thrift of house plants is more often due to the work of these maggots in the soil than is commonly supposed. Plate 42, figure 2, shows some geraniums that have been injured. In one large conservatory the majority of the plants were ruined. Among them were a beautiful eleven-year old fern, many begonias, colias, etc.

Drs. Chittenden, Hine, and others have reported injuries to peas growing in flower pots, and to lettuce, cucumbers and carnations. Dr. Hine states that they were living in the stems of the carnations. Dr. A. D. Hopkins has called attention to their work upon potato tubers. Dr. Forbes has called attention to their injury to seed corn, and the roots and bulbs of various kinds of flowering plants. Coquillett and Lintner mention them as being injurious to wheat, and we have in our own economic collection of insects, some *Sciara* specimens taken from wheat fields at Solomon, Kansas. They have been several times reported as working upon grass roots and we have found them

[1] These observations have been corroborated by Dr. Charles A. Shull, Associate Professor of Plant Physiology, and others.

boring in the crown of both clover and alfalfa, which leads us to believe that their economic importance has been somewhat overlooked.

Life-History

Technique Used.—The first studies in life-history were attempted by rearing the flies in small potted plants. Here, however, it was difficult to locate the eggs and impossible to observe the maggots. For studying the actual work of the maggots on the roots of plants, a flat glass device was used. This was filled with dirt and a geranium slip started. When this breeding box, shown in photograph Plate 41, figure 8, was placed on its side, some of the roots would come to lie against the glass. Thus when the maggots were found eating the roots, the whole device could be inverted and examined under binoculars.

The fact that the maggots fed upon roots suggested the possibility of carrying the life-history through on slices of potato in petrie dishes. The data for the life-histories were obtained by following the various stages on slices of potato in this manner, or in small potato cones in test tubes.

Dr. Robertson suggested that I sterilize potato in the auto-clave and add yeast—a modification of the banana and yeast plan employed by breeders of Drosophila. I reared one brood through in this fashion in thirty days.

Broods were reared in the soil of potted plants as a general check on the length of the life cycle.

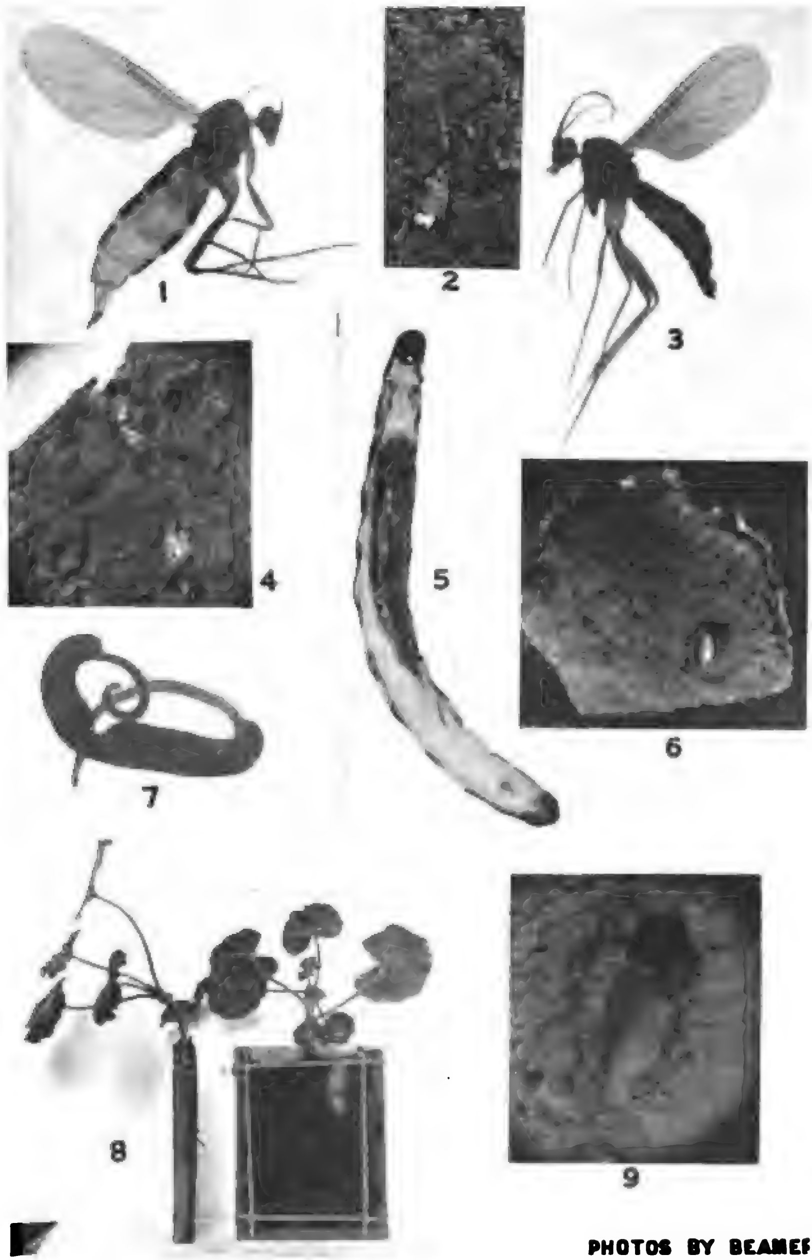
Stages in Life-History

The entire life cycle from egg-laying to egg-laying takes from twenty-four to thirty-two days. The adult female often begins ovipositing the day following her emergence. The egg stage and the pupal stage are quite constant as to the length of period, but an irregularity of several days frequently occurs even among the maggots hatching from one egg clump.

The Egg

The females lay from about seventy-five to one hundred and seventy-two eggs. These eggs are placed in declivities or irregularities of the soil. Often, where the soil has drawn away from the pot or the plant stalks, the female will follow down these crevices as far as possible and oviposit there.

The eggs are usually laid in clusters of from two or three to more than thirty. Individual eggs are oval and measure .24 mm. in length by .12 mm. in width. Clusters of them are quite plainly visible to the unaided eye. When first laid, the egg is of a pale greenish-yellow



PHOTOS BY BEAMER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PHOTOS BY BEAMER

color, but turns to pearly white in the course of a couple of days. About this time the head of the future maggot shows up as a shadowy patch that grows darker until by the end of the fifth day it is black and shiny and the embryo is active within this chorion. The eggs hatch in six days. In Plate 41, figure 4, is shown some egg clusters as they were laid in a small crevice of a potato; and Plate 41, figure 2, shows a female in act of laying—about two times natural size.

Larva

The larva when first hatched measures .65 mm. in length and is transparent. As soon as it begins to feed, the digestive tract shows as a dark line through the body. As it grows the body begins to take on a white color which is due to the large fat bodies within. *Sciara* maggots are characterized by their white bodies and black shiny heads. When grown the maggots measure about six or seven mm. in length and have the appearance shown in Plate 41, figure 5. About the eleventh or twelfth day, they begin to spin their cocoons which consist of a few threads of silk binding together loose bits of earth, fibre and the like. Larvæ of all stages have the power to spin out sheets and fibres of silk and sometimes use this power to form a cover to a tunnel in which they work. The larva preparing for pupation spends twelve hours or more making a very flimsy cell which is only a little more than two-thirds its length.

Pupa

Before pupating, the larva contracts to about 4 mm. and after a quiet period of some hours, changes to a naked pupa which is milky white in color. This gradually changes until just before emergence of the adult, the thoracic part is black and the abdomen shows the pattern of the adult. The pupal stage lasts from five to six days. Pupation usually takes place near the surface of the soil, though pupae are not uncommonly found deep down in the earth—indeed, adult flies are sometimes found imprisoned in deep spaces. The pupæ usually work their way to an open space before coming forth as adults. For this reason the surface of infested soils are often strewn with empty pupa cases.

Adults

The adult male and female of *Sciara coprophila* are shown in Plate 41, figures 1 and 3. These photos show their relative size and characteristics.

The female of this species measures about 3 mm. and the male measures 2.5 mm. Both are very active and are rapid runners though weak flyers. They are prone to hide under bits of earth or leaves on

the surface of the pot and "play possum" if disturbed. They are often found in houses where a few plants are kept during the winter months, and, as a rule, cause little concern. However, when they are being bred in large numbers in the favorable soils of the conservatory, they become a nuisance invading all parts of the house and at this time become especially annoying on the dining table where their accidental landing in butter and cream becomes somewhat trying to even the less fastidious.

Control Measures

The experiments for the control of these insects involved: 1st, protecting the plants by the use of repellents; 2d, destroying the maggots in the soil by the application of contact insecticides and stomach poisons; 3d, destroying the adult flies by the use of traps and poison baits.

Repellents

In this series of experiments, small geraniums in three-inch pots were used. The surface of the soil was covered to a depth of from one-fourth to one-half inch with various substances such as flowers of sulphur, pyrethrum powder, coarse sand, etc., and then exposed in a place where there were many flies and other similarly potted plants as checks. All of these plants were watered with like quantities of water and watered from the saucers. The results were not startling, though there were one hundred and fifteen dead flies near one pyrethrum pot. When the soil was examined the average number of maggots per pot were as follows:

Pyrethrum	5
Dried blood	114
Sand	0
Sulphur	0

From subsequent experiments it is evident that the attractiveness of the dried blood might have lowered the other counts somewhat. For in this connection it may be stated that as a result of exposing plants whose soils contained dried blood fertilizer and plants whose soils were ordinary garden soils, the ratio was an average of seven hundred and fifteen maggots per each pot to seven maggots. The larger number appearing in the soils containing dried blood.[1]

[1] One three-inch pot used in this as a trap was exposed a few days and then the surface of the soil carefully searched for eggs. The egg clusters were more numerous in a crevice between the pot and the dirt and in a similar place at the base of the plant on the shady side. The eggs in this case were arranged in clumps as follows: 8, 7, 5, 1, 15, 20, 15, 9, 21, 5, 9, 3, 5, 10, 16, 5, 7, 5, 2, 9, 5, 6, 3, 7, 2, 15, 8, 6, 2, 1, 3, 17, 5,—a total of 252 eggs, an average of 8— eggs to the cluster.

It was early noted that the flies showed a marked preference for soils having an abundance of moisture. Plants alike in every particular save in the amount of water received showed in one series an average of seventeen for the wet ones and none for the dry—a good suggestion for control, for besides rendering the soil unattractive to adults, the maggots already in the soil perish. However, many plants will not stand the lack of water and so experiments were made to see how well control could be affected by sanding the surface of the pots and watering from below. Besides presenting a surface unattractive to the egg-laying of the adult, the inability of the larvæ newly hatched to get down through the sand was demonstrated.

It also appears that pupæ already found in the soil have difficulty in getting through the relatively dry sand barrier. One hundred pupæ were placed in each of six pots, three of which were covered with one-half inch layer of rather coarse sand and water supplied from below. The counts were 3—1—0, for sanded pots and 97—92—94 for the check pots.

The depreciation in the former case may be normal mortality, or it may mean that some were injured in transferring them to the pots. In practical application of this method under conditions prevailing in our homes where ferns and begonias often predominate, the judicious combination of the methods above noted have given very satisfactory results.

In all the cases that have come to our attention, the presence of these flies has seemed due to soils rich in barnyard manure or treated with dried blood fertilizer. In one instance a lady who found that a large potted Lantana was supplying the flies that had been noticed all the fall, thought to help matters by emptying the remains of the teapot upon the inch of sand that had been placed on the surface of the soil. Some time later we were called in to see where the flies came from. A three-fourths inch layer of tea leaves was found, in the lower layers of which were hundreds of maggots. The maggots had gnawed the base of the tree somewhat but there did not seem to be maggots or pupæ in the sand below. Remedial measures were simple enough.

Destroying the Maggots in the Soil

All of the first efforts at control were directed toward destroying the maggots as they existed in the soil. The recommendations found in the literature were followed but with slight success. These included the use of lime water, kerosene emulsion, hellebore, carbon bisulphide, etc., and to this list were added experiments with: Black Leaf 40, in strength from one part to 1,000, and one part to 100. Sodium thiocarbonate, whale oil soap, borax water, and experiments in which the

soil was saturated with solutions of lead arsenate, Paris green and the like.

Two series of experiments were employed in the above; one with potted plants, soil of which contained maggots, and another in which slices of potato covered with the maggots were embedded in pots of sawdust, thus making simple the observations of the effects of the material used. The results in all of these cases either failed to kill the maggots or injured the plants.

It may be worthy of note here that Hart reports that a solution of from one-half to six per cent of nicoteen brought about premature emergence to the flies, thereby destroying them. He also states that the preparation repelled the larvæ. His work was with cucumber beds in a forcing house. The trouble here arose through the use of comparatively fresh manure as a fertilizer. He noted in this connection that when the manure was well rotted little or no injury followed.

It is to be hoped that the work now being done in various laboratories with nitrobenzine will lead to the discovery of some satisfactory applications for killing underground insects.

Destroying the Adults

Many flies were killed by the use of the following recommended by Sanders in "Minnesota Insect Life":

One-sixth ounce of sodium arsenate dissolved in a gallon of water and a pint of molasses. The flies preferred this mixture to combinations of it with stale beer and orange juice. The plants were allowed to become dry and then the sweetened mixture was sprayed over them with a syringe. They fed upon it greedily. However, under ordinary conditions, complete control could not be effected for the flies were not strongly attracted to it.

We had hoped to try the paradichlorobenzine so strongly recommended a year ago, but have been unable to obtain it even for experimental purposes.

Natural Enemies of Sciara Flies

In two references in literature that have come to our attention, certain Sciara maggots have been accused of parasitism. Mr. Peter Cameron 1875(3) declares them to be internal parasites of Sawfly larvæ. He states that the latter retain sufficient vitality to spin a cocoon inside of which the fly larvæ completes the destruction of their victims. Later, they quit the cocoon and change to pupæ in the ground.

Much later than this, Sciara was credited with preying upon Hessian fly puparia. If these cases are authentic, it is a step beyond the usual scavenger tendency we have so often observed.

However, Sciara maggots and adults are the hosts of a few forms. W. R. Thompson (19) gives an article "Sur un diptere Parasite de la larve d'un mycetophilidie." He found some Sciara maggots infested with parasites which he argues must be larvæ of a "Dexiid" or more probably of a "Tachinid."

In one series of experiments we had a number of three-inch pots of geraniums containing some dried blood fertilizer which were being used as a trap pot in a place where the flies were abundant. One pot sat in the corner of the infested bed and here a small nymph of an assassin bug (*Milyas*) took its abode, with the result that during the nineteen days of its presence there, it quite effectively kept the pot free from eggs.

In our study of the development of the eggs, we were at one time troubled by the predatory tendencies of a small mite which unfortunately we did not preserve for identification.

These same mites were seen to attack living flies, the wings of which held them captive to the moist glass.

There is, however one parasite, a nematode, that most efficiently reduced my stock of flies to the vanishing point just recently. It works within the maggot and reaches maturity there. Though the parasite occupies most of the space within the maggot, the latter is sometimes permitted to become an adult, minus, however, all traces of its organs of reproduction. Plate 41, figure 7, shows an adult female parasite. The life-history of this nematode and its effect upon the host will appear in another publication.[1]

Summary

The life-history of *Sciara coprophila* requires a period of from twenty-four to thirty-two days. The egg stage occupies six days, the maggot stage twelve to fourteen days, or longer, the pupa stage six days and the adults have lived under laboratory conditions about a week. The maggots, though omniverous feeders, are injurious to potted plants through their feeding upon the roots and root hairs.

Soils that are moist and rich in manure or dried blood attract the the flies and lead to the laying of large numbers of eggs in these favored situations, the result being that plants growing in soils of this character are seriously damaged.

The maggots, though resistant to most insecticides, quite readily succumb to drying. Thus, by letting the soils dry out occasionally, little trouble will be experienced. Where a serious infestation occurs, a judicious drying out of the soils, use of dry sand on top of the dirt, and trap pots of dried blood and earth and sprouting grain used to attract egg-laying, will effectually control the pest. The maggots

[1] See also Bezzi (2) for others.

and eggs in these trap pots should be destroyed about every two weeks by submerging in boiling water.

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Plate 41

Figure 1. Female *Sciara coprophila*.
Figure 2. Female ovipositing showing the wings in nearly their normal position.
Figure 3. Male *Sciara coprophila*.
Figure 4. Eggs of *Sciara coprophila* deposited in a crevice in the upper surface of a bit of potato tuber.
Figure 5. The maggot of above named fly.
Figure 6. Pupa on surface of potato showing the nature of its pupal chamber.
Figure 7. Adult ♀ nematode with egg capsule dissected from an infested maggot.
Figure 8. Device for studying the food habits of the maggots.
Figure 9. Enlarged view of pupa shown in Figure 6, to show the chamber of bits of foreign material tied together with silk fibres.

Plate 42

Figure 1. Geranium slip killed by the work of Sciara maggots.
Figure 2. Geranium plants that owe their straggly appearance to the work of the maggots in the soil.
Figure 3. Close view of lower portions of plant shown in Figure 1.
Figure 4. Begonia plant in a poorly drained vessel with a soil rich in manure. An ideal place to breed Sciara.
Figure 5. Corn roots riddled by the maggots.
Figure 6. Geranium plant and its curtailed root system.

NOTES ON THE CONTROL OF THE WHITE PINE WEEVIL

By S. A. Graham

Yearly the white pine weevil, *Pissodes strobi* Peck, takes its toll of young white pines and Norway spruces, and in recent years it has received considerable attention not only from entomologists, but from foresters and nurserymen as well. A number of control measures have been suggested, some of which are undoubtedly valuable under favorable conditions.

During the past season the writer has applied different materials at various strengths as sprays and washes to the young pines, in an

effort to find a control for this pest in nurseries. Although the experiments were not on a large enough scale to be conclusive, still the results in some cases were very gratifying.

Spraying in forest plantings is of course economically impossible, but if an effective material can be found it should prove to be of the greatest value in commercial nurseries and in ornamental plantings.

Approximately five hundred adult weevils were freed during the early spring in the plots treated in order that a heavy infestation might be insured.

The results of the experiments are set forth in the following table:

EXPERIMENTS ON WHITE PINE WEEVIL

Material	Date of Application	Method of Application	Strength	Injury	Trees Treated	Trees Weeviled
Kerosene emulsion	Apr. 26, 1916	Painted	1 to 3	Considerable	10	5
Creosote emulsion	Apr. 13, 1916	Sprayed	1 to 2	None	10	3
Creosote	Apr. 13, 1916	Painted	Pure	Badly injured	10	0
Carbolineum	Apr. 13, 1916	Painted	Pure	Growth stunted	10	0
Creosote	Apr. 13, 1916	Sprayed	Pure	Very slight	10	0
Carbolineum	Apr. 13, 1916	Sprayed	Pure	None	10	0
Soluble sulphur	Apr. 26, 1916	Sprayed	4 lbs. 100 gal.	None	10	4
Lime sulphur	Apr. 26, 1916	Sprayed	1 to 8	None	10	5
Scalecide	Apr. 26, 1916	Sprayed	1 to 25	None	10	8
Powdered lead arsenate	May 6, 1916	Sprayed	3 lbs. 50 gal.	None	10	3
Powdered lead arsenate	May 6, 1916	Sprayed	2 lbs. 50 gal.	None	10	2
Paste lead arsenate	May 6, 1916	Sprayed	5 lbs. 50 gal.	None	10	4
Paste lead arsenate	May 6, 1916	Sprayed	10 lbs. 50 gal.	None	10	2
Calite	May 6, 1916	Sprayed	1 to 50	None	10	3
Calite	May 6, 1916	Sprayed	2 to 50	None	10	3
Carbolic emulsion	Apr. 26, 1916	Sprayed	1 to 3	None	10	4

CHECK TREES

Group	No. of Trees	No. Weeviled
1	30	8
2	6	2
3	10	3
4	10	5
5	10	4

The check trees were scattered in groups through the stand and were infested as shown in the above table.

From the above tables it is evident that none of the materials used proved effective with the exception of the creosote and the carbolineum. Lime-sulphur at scale strength, which has been recommended as a deterrent, in this trial at least, proved valueless. Neither was it found possible to poison the adult weevils with arsenicals, although very strong solutions were used. Since the pine weevil works only on the terminal shoots it is only necessary to apply the spray or wash to that part of the tree.

Before either carbolineum or creosote can be unreservedly recommended more extended experiments will be necessary, for there seems to be some danger of injury to the trees. The carbolineum showed less injury than the creosote. In no case did either material kill a shoot but the growth of the trees injured was stunted or stopped altogether.

In addition to these sprays and washes tanglefoot was applied to forty trees. The purpose was to determine whether the weevil flew to the terminal or crawled up the tree from the ground for feeding and oviposition in the spring.

Two bands were placed around the stem of each tree, one just above the topmost whorl and one on the trunk just above the ground. It was thought that the weevils crawling up from the ground would become entangled in the lower band, those alighting in the branches and completing the journey to the terminal by crawling would be caught in the upper band, and only those which flew directly to the terminal shoot would escape.

In order to insure a heavy infestation two hundred adult weevils were freed in the tanglefoot plot. The day following their introduction a large proportion of these weevils were found collected below the lower bands, but none were found on the terminal shoots, and none were found caught in the tanglefoot. Not a single time during the season was a weevil caught in any of the bands.

Up to the fifteenth of June none of the trees treated with tanglefoot were infested. On the twenty-first of July, however, three weeviled shoots were found in the plot. It is possible that the tanglefoot became glazed and hard enough, during the cold rainy weather the latter part of June, to permit its being crossed by the weevils.

Out of the thirty check trees in this plot eleven were weeviled.

From these results it is safe to say that the three substances tanglefoot, creosote, and carbolineum deserve further trial on a larger scale.

Further results from these and other experiments on weevil control now under way will be published later.

NOTES ON THE TWELVE-SPOTTED CUCUMBER BEETLE

By R. A. Sell

WILL THE TWELVE-PUNCTATA BECOME A FLOWER BEETLE?

The Twelve-spotted Cucumber Beetle or 12-punctata (*Diabrotica duodecim-punctata* Oliv.) is becoming more numerous in southern Texas. Four years ago comparatively few of these beetles could be found about Houston and these worked upon cane and truck crops, but this year they can be found most anywhere and they attack a great number of plants. Owing to an unusual period of dry weather the

cultivated crops that they prefer were not plentiful before the 10th of June but the beetles were very much in evidence; working upon cultivated flowers, ornamental shrubs and occasionally upon trees and vines. During April, May and the first ten days of June they were found on two hundred and eighty plants—besides the ones which they commonly feed upon: spinach, kale, peas, cucumber, melon, cantelope, pumpkin, beet, mustard, turnip, peanut, corn, cane and coffee-bean, they were noticed on peaches, plums and strawberries and also on such plants as petunias, four-o'clocks, narcissus, wisteria, sweet-peas, jack beans, catalpa, morning glories, touch-me-nots, cape jasmine, and many others. While they sometimes gnawed the leaves of morning-glories, wild sweet potatoes, touch-me-nots and four-o'clocks, they seemed to prefer the pollen, the essential organs or the petals.

To gain some idea of the range of their distribution on native plants at one particular time an extensive trip was made through the woods and fields that were in the wild state or at least as free from cultivated plants as possible. On April 28 they were found on wild plants as follows: *Erigeron* sp., *Rudbeckia hirta*, *Cathartolinum rupestre*, Asteraceæ, *Medicago hispida*, *Allium helleri*, *Echinacea pallida*, *Hartmannia speciosa*, *Chenopodium album*, *Plantago aristata*, *Daucus pusillus*, *Cornus stolonifera*, *Verbená bracteosa*, *Vicia cracca*, *Lantana macropoda*, *Ptelea mollis*, *Monarda fistulosa*, *Erythrina herbacea*, *Xanthoxalis corniculata*, Apiaceæ sp., *Verbena stricta*, Smilax, *Verbena officinalis*, *Laurocerasus caroliniana*, *Carpinus caroliniana*.

In most instances they were working upon the flowers, usually the pollen.

Feeding Habits; Effects of Changing Food

Some experiments in adapting them to different kinds of food were tried and in every case they were able to change from an exclusive diet of one kind of food to another without any more serious consequences than a loss of appetite for a few days. Several kinds of plants they would not eat, even after a fast of eight or ten days.

While they will thrive on cactus blossoms the leaves of this plant do not agree with them. Under ordinary conditions they will not eat cactus leaves but after twenty-eight beetles had been kept without food for four days a supply of cactus leaves was given to them and they ate rather sparingly. In twenty-four hours eight of them were dead but the remaining twenty lived sixteen days with no other food, when two more died. Some of them became quite lively on this diet and after twenty-two days' imprisonment began to copulate.

It appears that the *12-punctata* is not as hardy an insect as the *soror*. It is by no means as ready to eat anything that is convenient but it shows a decided ability to meet conditions of shortage in a particular kind of food.

Hibernating, How They Spend The Winter

Preliminary investigations seem to indicate that not much is definitely known as to how the *12-punctata* spends the winter. A large part of the observations made upon the hibernation of this insect consists of inferences drawn from the behavior of allied species that have been carefully studied in many localities but such analogies cannot always be relied upon to hold even with a very closely allied species. It is quite probable that the way of spending the winter for this beetle depends upon many conditions as: duration and intensity of cold weather, rainfall and sunshine and the prevalence of food plants. Mr. F. H. Chittenden of the U. S. Department of Agriculture is collecting data from several localities concerning the habits and life-history of the *12-punctata*. If this method is pursued for a few years the exact effect of the various factors that control hibernation can be ascertained.

With Mr. George Findlay Simmons of Rice Institute the writer undertook to observe the hibernating of a number of *12-punctata*. In the early part of December when the beetles became scarce it seemed that they would soon hibernate. The great storm of the preceding August had destroyed most of the foliage, and the leaves, grown after that, were too tender to stand the frost, hence the woods were much more barren than usual. The last wild plant that they really worked on was the coffee bean (*Daubentonia longifolia*) and throughout the entire winter if a coffee bean plant could be found, in some sheltered spot in the woods, it would be tenanted by one or more of these beetles and some fresh gnawed notches along the edges of the leaf would show where the insect had worked. At first the belted cucumber beetle (*Diabrotica balteata*) could be found with the *12-punctata* but these disappeared about December 15.

The Department of Biology of Rice Institute has constructed an outdoor vivarium with a portion enclosed only by wire screen. In this enclosure where the conditions were essentially the same as outdoors, thirty-two beetles were installed. First they were supplied from time to time with fresh leaves but as they showed no disposition to hibernate the supply was not renewed. They were active at all times. On dull days a beetle would take a position on a twig with its thorax drawn forward as though it was about ready to raise its wing covers, and draw its forelegs slightly above its body with the antennæ either forward or twitching slightly. While it might hold this position for hours it was by no means asleep. The position of this beetle when asleep is that of repose—the abdomen is relaxed, the wing covers carefully drawn together and the legs firmly planted against the resting twig.

This position seemed to indicate a response to some instinct for hibernation and was carefully watched for several weeks but they did

not hibernate. The insects did not appear to be especially plump and heavy but they no doubt possessed some form of fatty or energy producing tissue as shown by experiments that were made. Dr. Huxley suggested that there might be such material stored in the bodies of the insects which in a measure would obviate the necessity for hibernating under certain conditions.

Stored Up Energy

It has been noted by several observers that these beetles cannot continue on wing for any great length of time and that if they are obliged to turn often, as in trying to escape from a room, they soon fatigue.

Five beetles that were captured the day before on spinach were turned loose in a room 36 x 60 and kept on wing until they could not be stimulated to take to wing. Feather dusters, horns, squawkers and lifters were tried as a means of keeping them on wing but the most satisfactory results were obtained from the use of a small hand bellows. A piece of cloth saturated in camphor was tied over the nozzle. A beetle was considered fatigued when this appliance failed to make it fly. One of the males was fatigued in eleven minutes and the other one in sixteen minutes while it took twenty-two minutes tofatigue one female, twenty-six minutes for another and thirty-two minutes for the last.

On another test under similiar conditions (November 6) with five females, they were fatigued with an average time of twenty-two minutes. These were fed on spinach three days and then fatigued in an average time of twenty-six minutes. After a fast of five days they were able to stay on wing twenty-eight minutes.

December 17 five males were fatigued with an average of sixteen minutes, but one of them was fatigued in eight minutes while it took twenty-four minutes to fatigue another one.

December 19 five females that had been without food for about two weeks were fatigued in thirty-two minutes.

As there seemed to be a steady gain in ability to keep on wing after fasting, records were kept to show how long they had fasted with their average time. This was known as Lot 1. A fresh lot of five was brought in from a turnip patch December 20. This was known as Lot 2.

Lot 1

Dec. 19	Fatigued	in	32	min.	after	fasting	14	days.
20	"	"	30	"	"	"	15	"
21	"	"	34	"	"	"	16	"
22	"	"	31	"	"	"	17	"
24	"	"	34	"	"	"	19	"
25	"	"	38	"	"	"	21	"
27	"	"	33	"	"	"	23	"
28	"	"	33	"	"	"	24	"
29	"	"	36	"	"	"	25	"
30	"	"	35	"	"	"	26	"
31	"	"	38	"	"	"	27	"

Jan.	1	Fatigued	in	37 min.	after	fasting	28	days.
	3	"	"	34 "	"	"	29	"
	4	"	"	39 "	"	"	32	"
	5	"	"	37 "	"	"	33	"
	6	"	"	36 "	"	"	34	"
	7	"	"	38 "	"	"	35	"
	8	"	"	40 "	"	"	36	"
	9	"	"	39 "	"	"	37	"
	10	"	"	38 "	"	"	38	"
	11	"	"	41 "	"	"	39	"
	12	"	"	39 "	"	"	40	"
	13	"	"	42 "	"	"	41	"
	14	"	"	36 "	"	"	42	"
	15	"	"	42 "	"	"	43	"

LOT 2

Dec.	26	Fatigued	in	24 min.	after	fasting	6	days.
	27	"	"	22 "	"	"	7	"
	28	"	"	26 "	"	"	8	"
	29	"	"	20 "	"	"	9	"
	30	"	"	23 "	"	"	10	"
	31	"	"	22 "	"	"	11	"
Jan.	1	"	"	24 "	"	"	12	"
	3	"	"	26 "	"	"	14	"
	4	"	"	25 "	"	"	15	"
	5	"	"	27 "	"	"	16	"
	6	"	"	23 "	"	"	17	"
	7	"	"	26 "	"	"	18	"
	8	"	"	26 "	"	"	19	"
	9	"	"	28 "	"	"	20	"
	11	"	"	30 "	"	"	22	"
	12	"	"	26 "	"	"	23	"
	13	"	"	24 "	"	"	24	"
	14	"	"	26 "	"	"	25	"
	15	"	"	31 "	"	"	26	"
	16	"	"	33 "	"	"	27	"
	18	"	"	35 "	"	"	29	"

In general terms there is a gain in endurance corresponding to the time of fasting. One of the beetles in Lot 2 died January 18. January 12, five females were taken from a cage containing about sixty beetles which had been kept since November with plenty of food. While they appeared lively they were fatigued in fourteen minutes. They were tried on different days but some one of them would usually give out in six or eight minutes. After a fast of fourteen days their average was eighteen minutes and after sixteen days they were fatigued in twelve minutes. Under the conditions it seems hardly probable that they had become accustomed to confinement. Would it not seem that nervousness attending the unusual conditions of confinement had interfered with their life processes and prevented the usual storage of energy producing material? Within limits it seems that the longer they fast the greater is their power of endurance! Do they prepare for winter by storing tissue that is available for migrating purposes

localities where they do not need to hibernate? Is it possible that this material becomes more available for transmission into energy as the time for them to begin a search for food approaches? Does exercise tend to make the food material available? They could not be kept successfully in a cage too small for them to fly about.

While observations were not made so as to form a definite conclusion, it appeared that these insects could endure a fast much longer when exercised even in this violent manner than when confined in a reasonably warm room. It is certain that the beetles that were exercised to fatigue almost every day without food were much more lively than those kept in cages with plenty to eat.

Field Habits

On the 18th of July an experiment was begun with the object of studying their habits of distributing themselves over the fields. The country around Corpus Christi, Texas, had been without rain for fourteen months until the first part of July when showers, more or less local, began falling. These showers continued until there was so much rain that farmers could not keep the weeds out of the fields. Here was an area of six counties in which it seemed that very few beetles had spent the winter, hence all or nearly all that were present had lately come in from the irrigated districts of the lower Rio Grande valley.

One hundred and sixty-seven beetles were marked by painting their wing covers with a dash of India ink. The next day but three of them could be found. Four hundred and twenty-four beetles marked in like manner disappeared so completely that only five could be found the next day. One evening thirty beetles were located on plants where they were spending the night but none of them returned to their respective plants the next night. Several other experiments were tried with similiar results. It appears that at this season under such conditions the beetles are not influenced by a "homing instinct" or even a locality instinct. On August 2 some young larvæ were found.

THE PRIVET MITE IN THE SOUTH

By E. A. McGregor, *Bureau of Entomology*

Introduction

In connection with the observations at Batesburg, S. C., during the past five seasons on the common red spider, I have had considerable opportunity to study the little known privet mite (*Tenuipalpus bioculatus* McG.[1]). Concerning its origin little seems to be known, but since all our records of the occurrence of the species have been from the seven southeastern states—North Carolina to Louisiana inclusive—it would appear that the privet is confined mainly to this area.

[1] "Four New Tetranychids," Ann. Ent. Soc. Am., Vol. VII, 4, pp. 354–360, pl. IV.

Character of Attack

The species is not entirely confined to privet (*Ligustrum* spp.) hedges but a marked preference seems to be exhibited for this host. A remarkably high percentage of privet hedges are infested and the resulting damage is often very noticeable. Unlike many other pests, the privet gains impetus with the approach of fall and the heaviest infestations usually occur in September and October in the South.

The feeding takes place on the under surface of the leaves where reproduction continues until often the leaves are entirely over-run and swarming with the mites in all stages. No marked discoloration is discernible, as is the case with the common red spider, but a yellowing or fading of the infested leaves is usually noticeable. The heavy draining of the vital juices of the leaves through the many feeding punctures causes a marked weakening of the foliage. This, perhaps together with certain toxins introduced by the mouthparts, results finally in the shedding of many leaves until, in severe infestations, the plants become entirely defoliated (see Pl. 43, fig. 1).

One season's defoliation rarely results in the death of privet bushes. A second crop of leaves is soon developed. Owing, however, to the proximity of the bushes, in the case of hedges, this new foliage generally becomes readily reinfested. Upon the destruction of the secondary foliage the vitality of the bush becomes greatly reduced so that either death or great weakness follows. Often the attack centers acutely upon a single bush with the result that it finally succumbs leaving a gap (see Pl. 43, fig. 2) in the hedge which is not easily repaired.

Food Plants

Although by far the commonest host of this pest appears to be privet (*Ligustrum amurense* and other species), we have records of its occurrence on *Rumex acetosella*, *Oxalis stricta*, garden mint (*Mentha spicata*), strawberry, Boston ivy, golden-rod (*Solidago* sp.), the palm, *Phœnix humilis* and on orange and lemon. Doubtless this host list is by no means complete, and the diverse nature of the above species indicates that the privet mite is to some extent a general feeder.

Description

Female—Body crimson, with two rather well-defined eye-like spots on cephalothorax. Widest at posterior corners of cephalothorax, two-thirds as wide as long. The cephalothorax is narrowed considerably anteriorly, and the abdomen tapers to a rounded tip. The body is armed with a pair of weak spines on the anterior body margin medially, similar spines immediately before and behind the emarginate eyes, six at the posterior tip of the abdomen, and a few along the body margin, and scattered ones dorsally. The cephalothorax is hardly half as long as broad, with the anterior margin convex; the palpi greatly resembles the *Tetranychus* type, the penultimate joint bears a strong claw, and the terminal joint (thumb) bears a "finger." The legs are relatively stout, crenulated; forelegs in length three-quarters the width of cephalothorax; four anterior tarsi blood-red in life; all legs bearing several lateral hairs, and a terminal bristle in length equalling the three distal segments; the tro-

chanter of the four anterior legs with a lamellate hair placed dorsally; the tarsi with several terminal appendages including a pair of closely appressed claws, a very long bristle, and the four capitate hairs, so frequently seen in *Tetranychus*.

Length, 0.235 mm.; width (hind margin of cephalothorax), 0.149 mm.

MALE.—The male is decidedly smaller than the female, and the abdomen is suddenly constricted behind the cephalothorax and decidedly more attenuate than is the case with the female. The legs of the male are relatively longer, colorless, and the hairs and bristles are more conspicuous.

LIFE-HISTORY

THE EGG.—The egg is thickly elliptical in linear outlines, and measures .096 mm. by .067 mm. It is blood red in color from the first. The eggs are usually deposited with the long axis perpendicular to the leaf. An effort is made by the female to deposit the eggs in a depression or abrasion of some kind. These failing, she deposits them in old molted skins (see fig. 38*c*) or in the groove by the side of the mid vein. When oviposition is taking place freely the eggs often become closely packed (like those of Coccinellids), often comprising clusters of several hundred. It appears from our limited breeding experiments that the female deposits usually about twenty eggs.

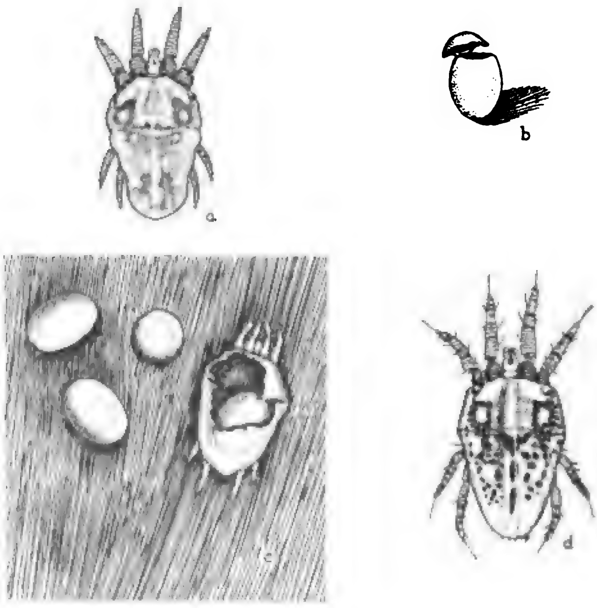


Fig. 38. *a*. Drawing showing outline and color patern of deutonymph of *Tenuipalpus bioculatus* McG.; *b*. Manner of hatching of egg of *Tenuipalpus bioculatus* McG. X 130; *c*. Eggs of *Tenuipalpus bioculatus* McG. on privet leaf. Two eggs are on side, one is on end, one egg has been deposited in the molted skin of a nymph. X 130; *d*. Drawing of adult female of *Tenuipalpus bioculatus* McG.

Fig. 1. Damage to privet hedge by the privet mite (*Tenuipalpus bioculatus* McG.). Portions of hedge between A and B have been almost entirely defoliated.

Fig. 2. Photograph of privet hedge showing dead bush which was killed by repeated attacks of the privet mite (*Tenuipalpus bioculatus* McG.).

Incubation

Doubtless, as is the case with the common red spider, the duration of the incubation period varies with the climatic conditions. We find that the length of this period during hot weather is about eight days at Batesburg, S. C.

TABLE I. DURATION OF THE EGG PERIOD

Period	Duration (days)
June 19 to 27	8
June 24 to July 1	7
June 18 to 27	9
Average	8

Larva

In hatching the eggs rupture transversely near the anterior end. The larva leaves the egg head first. The lid of the egg often remains attached as a cap (see fig. 38*b*). In the one case witnessed the hatching required over thirty minutes. The larva is 6-legged; the body color is a bright crimson whereas the legs are nearly colorless. The just hatched larva is feeble and travels very slowly. The six posterior spines are much more conspicuous in the larval than in the later stages; they are more lamellate and are distinctly serrate. Table II presents the data for four reared larvæ.

TABLE II. DURATION OF THE LARVAL PERIOD

Period	Duration (days)
June 27 to July 1	4
June 29 to July 3	4
June 29 to July 4	5
June 27 to July 3	6
Average	4.7

The molt of the larva, as for all other stages, takes place through a transverse rupture at the suture between the cephalothorax and abdomen, quite similar to that of the red spiders. In molting the individual often crawls inside a shed skin of an older stage, and it is customary to see two or three shed skins telescoped one inside the other.

Protonymph

As is commonly the case with mites, the molt to the primary nymph results in an added pair of legs—making eight in all. The feeding protonymph quickly gains in size over that of the larva and becomes of a somewhat darker color.

TABLE III. DURATION OF THE PROTONYMPHAL PERIOD

Period	Duration (days)
July 2 to July 7	5
July 1 to July 5	4
Average	4.5

DEUTONYMPH

Following the molting of the protonymph, which in every respect is quite like that of the larval molt, the appearance of the deutonymph (Fig. 38, *a*) is very much like that of the earliest nymphal stage. It differs only in the increased size, the slightly deepened color, and the greater reduction in size of the spinous appendages. Table IV presents the results of the two bred deutonymphs.

TABLE IV. DURATION OF THE DEUTONYMPHAL PERIOD

Period	Duration (days)
July 1 to July 5	4
July 1 to July 5	4
Average	4

GENERATIONS

From the foregoing it will be seen that the development of a generation of privet mites takes place about as follows:

	Days
Incubation period	8
Larval period	4.7
First nymphal period	4.5
Second nymphal period	4
	21.2

A generation in summer time, therefore, requires about three weeks for completion in the latitude of Batesburg, S. C. It seems probable that in South Carolina there are six or seven generations in the course of a season. This has not been definitely determined, however.

LONGEVITY

The rearing of *Tenuipalpus* was beset with several difficulties such as predators, humidity control, rain, etc. Although an effort was made to simulate natural conditions, entire success was not attained. In spite of this we believe that the conditions surrounding our experiments were not sufficiently inimical to greatly influence the results. Of our four experimental females the individual longest under observation lived 17 days within the isolation cell and deposited in that time 18 eggs: the next longest record was 14 days in which time 13 eggs were deposited.

Reported Occurrences

Dade City, Fla. Injury to privet. W. W. Yothers.

Olando, Fla. Privet hedges largely defoliated in the fall and spring of 1913. W. W. Yothers.

Charleston, S. C. Much damage to privet in 1913. W. W. Yothers.

Auburn, Ala. Much defoliation and damage to privet hedges. Dr. W. E. Hinds.

Agricultural College, Miss. Considerable destruction to privet hedges on the campus and at other points in Mississippi. R. W. Harned.

Baton Rouge, La. Defoliation of privet. E. S. Tucker.

Batesburg, S. C. Frequently inflicts severe damage to privet hedges. Author.

Control

Several insecticides have been tested against this species. Lime sulphur gave practically complete mortality. Following are the results of the test.

Sprays	Mortality
Lime sulphur (Thomsen Chem. Co.)	99%
Potassium sulphid	90%
Nicotine sulphate	Less than 5%

SOME EFFECTS OF FREEZING ARSENATE OF LEAD PASTES

(Preliminary Paper)

By R. Adams Dutcher, *Department of Chemistry, Oregon Agricultural College, Corvallis*

Introductory

From time to time inquiries have been received at the Oregon Experiment Station relative to the use of arsenate of lead pastes which have been frozen during the winter months. Fruit-growers have observed in certain instances that the appearance of the pastes after freezing was different from the unfrozen material and some men have even insisted that the insecticidal value of the spray had been impaired by freezing.

Manufacturers of some of the commercial pastes advise that all frozen materials be shipped back to the factory or thrown away; while others maintain that freezing has no effect on their product.

The same question was brought to the writer's attention while teaching the chemistry of insecticides to a class of agricultural students.

One student maintained that a prominent fruit-grower was forced to return several hundred pounds of arsenate paste to the manufacturer, and it was observed that the frozen paste was much more granular than the original material.

In talking the question over with Mr. A. L. Lovett, Station Entomologist, it was agreed that a number of letters should be written to prominent entomologists and manufacturers, asking them to state if in their opinion the arsenates of lead were harmed by freezing. Nineteen letters were received in answer to the inquiry. Eight of these men (42 per cent) took the stand that freezing had no effect on the efficiency of the arsenate sprays. Six specialists (31.6 per cent) stated that there was no doubt in their minds as to the harmful effects obtained and under no conditions should the frozen arsenates be used. Five writers (26.3 per cent) were either doubtful or confessed to no definite knowledge regarding the question.

Mr. Richardson of the New Jersey Experiment Station stated that Mr. C. S. Cathcart, Station Chemist,

obtained a sample of frozen arsenate of lead and made a careful analysis of it. He was unable to discern any change in the amount of arsenic oxide, water soluble arsenic, etc., in this sample and came to the conclusion that freezing did not in any way alter the chemical composition of the material.

W. E. Britton, State Entomologist for Connecticut, presented the following statement:

We know that it must freeze, and we have never hesitated to use it in our work the following season. Sometimes the mechanical condition is changed somewhat, but this comes more from drying than from freezing. If it becomes dry, as you know, it is apt to be lumpy, and it is hard work to again pulverize it, so that it will remain in suspension or so that the particles will be finely divided.

A prominent manufacturer wrote as follows:

As you know, arsenate of lead in the form that ours is in, known as the "hydrogen," is a very tight combination, and a very stable compound. We have experimented a number of times in freezing our material, and then mixing it with water, for suspension tests. Also, freezing it, and then drying it out, so that it was water-free, and breaking it up. In all our experiments we have never been able to alter the physical and mechanical values of our arsenate of lead paste through freezing. It never broke down in any way, causing an injurious effect on foliage.

In support of the harmlessness of using frozen arsenate the manager and entomologist for another chemical manufacturing house states:

So far as I have seen, practically all brands of lead paste of recent manufacture lose nothing in efficiency on being frozen. With some brands the solid matter has a tendency to settle more hard in the bottom of the container and consequently is more difficult to get into proper suspension after freezing, but I have purposely made several tests on rather extensive areas and in every case the results in worm control were

just as good with the frozen lead as with the same brand of lead before freezing, the only objection being the slight extra work needed in getting the paste properly mixed with water.

The research department for a commercial house also supported this view as shown in the following letter:

We have found that if the frozen arsenate of lead is allowed to stand in a warm enough place so that it can thaw out, there is apparently no difference in the form of paste arsenate lead. It is barely possible that the physical condition of this frozen lead when thawed is not quite as smooth as when originally made, but this is very hard to state authentically as the difference is so awfully small. We have had a considerable number of samples of arsenate lead analyzed after they have been frozen and thawed out and there is no indication whatever that the soluble arsenic has increased from the original amount that was in it when manufactured. As the soluble arsenic is the biggest indication as to the changes that might take place, we think we are perfectly safe in stating that no chemical change has taken place.

Another manufacturer says:

Our investigations indicate that the chemical properties of arsenate of lead are not affected in any way by freezing, but the physical properties are to the extent that it usually causes moisture separation, and it sometimes causes the material to become granular and coarse and because of this there may be trouble by clogging the nozzles. However, if this frozen material can be worked up into a good, smooth paste, and it can be if the grower is willing to go to the trouble to do so by the slow addition of water and using a good paddle, it will be in entirely good condition to use.

In opposition to this view Mr. L. Haseman of the Missouri Station writes:

This I do know—if arsenate of lead paste is permitted to freeze, it tends to form a coarser preparation and more difficulty is encountered in keeping it in suspension.

W. J. Schoene of the Virginia Station contends that:

The general impression is, however, that once paste lead arsenate has become thoroughly dry it no longer has any value.

The manager for one of the houses manufacturing a paste used in large quantities on the Pacific Coast is quite emphatic in showing the harmful effects of freezing the arsenate pastes. He writes in part as follows:

With reference to your inquiry regarding arsenate of lead in the paste form after it has been frozen, would like to say that so far as I know, the publications and statements of the manufacturers are not based on experimental data, but are based on a knowledge of how these things act when compressed and on actual experience. For instance, most manufacturers have had at some time, experience on frozen arsenates of lead and after thawing them out, they have found that the paste itself gives up a great deal of its original water and that it was impossible to put this arsenate of lead back into its original form, as denoted by such tests as the difference of the suspension in water, adhesive properties, etc. Freezing has a tendency to granulate the

paste to such an extent that its smooth mixing properties, suspension properties and adhesive qualities are considerably injured. Also it has been shown by a great many complaints which have come to the personal knowledge of the writer during his experience, that a frozen arsenate of lead had been used in the spraying applications and apparently did not control the worms. It has been quite evident from investigations made of such complaints, that the trouble was in using the frozen material and the reasons why it was not active, I am inclined to believe, are because of the injured properties of adhesiveness, fineness, spreading power, etc. It is only the physical properties that are injured and not the chemical properties. I have seen frozen arsenate of lead dried out and reground and it seemed impossible to put it back in its original smooth state.

No less emphatic is the statement made by the horticulturist for a prominent commercial company:

In reply beg to advise, that the only experience we have had with handling frozen arsenate of lead is that it is rendered physically unfit for use; the paste being exceedingly hard to work up after having gone through freezing process. The powdered is not harmed by freezing according to our experience and I think in the case of both, paste and powdered, there is no important chemical change, which would affect the insecticidal properties of material.

Experimental

In view of the contradictory statements given above, a few preliminary experiments were conducted to determine the effect of freezing on the physical properties of some commercial arsenates of lead.

Six commercial brands of lead arsenate paste and pure samples of acid and basic lead arsenates were each mixed until uniform and divided into equal portions and placed in glass stoppered salt mouth bottles. One bottle from each paste sample was placed in an ice and salt mixture and left for 24 hours. Evaporation was prevented by the use of ground glass stoppers and as soon as the samples had thawed, the water and lead arsenate was mixed thoroughly until a uniform paste was obtained. Many of the frozen pastes appeared much more granular than the unfrozen duplicates.

Exactly 10.3 grams of each of the arsenate samples were weighed and suspended in 1000 cc. of distilled water. This is equivalent to "4 pounds to 50 gallons" as used in ordinary practice. Tests were made on these samples to see if freezing had affected the property of the lead arsenate to remain suspended in water. The following photographs on Plates 44, 45 are self explanatory. (The numbers are in duplicate. N.F. = Not Frozen, F. = Frozen.)

Figures I and II of Plate 44 represent the frozen and unfrozen samples 2 minutes after shaking: Samples 1, 2 and 4 show the greatest difference; the frozen arsenates have a curdy appearance and settle much more rapidly. Figures III and IV on Plate 45 represent the samples as they appeared after standing for fifteen minutes. The striking

1 Fig. 1.

2 Fig. 2.

3 Fig. 3.

4 Fig 4

feature of this experiment is that different commercial brands behave differently under the same treatment. It is also interesting to note that pure lead acid arsenate (sample 7) and pure lead basic arsenate (sample 8) show no difference in settling properties after freezing.

In order that some idea might be obtained as to the effect of freezing on the adhesive properties of the arsenates an experiment was conducted as follows: Strips of aluminum were cut so that each strip measured exactly ¾ x 2¼ inches, giving an area of 1.6875 square inches for each strip. These strips were roughened, by dipping in strong hydrochloric acid, in order that the arsenate solution might adhere to better advantage. These strips were washed, dried, and weighed.

Sample 1 was set aside for this experiment because it was representative of the type affected by freezing. Sample 3 was also chosen because its settling properties were not appreciably affected. This sample was a stearated[1] or water-proof arsenate of lead. Sample 6 was chosen because it represented that class whose settling properties were not affected by freezing. In order that no errors be made two strips were dipped into each sample while it was being agitated; these strips were hung on fine copper wires and finally dried and weighed. The results are given in Table I.

TABLE I

Sample of Lead Arsenate	Weight of Empty Strips	Weight of Strips plus Arsenate	Average Weight of Arsenate
1 N. F.	a. 2.3918	2.3925	.0007
	b. 2.3459	2.3466	
1 F.	a. 2.4259	2.4264	.0006
	b. 2.3532	2.3539	
3 N. F.	a. 2.3067	2.3074	.0009
	b. 2.3427	2.3439	
3 F.	a. 2.3276	2.3278	.0003
	b. 2.3716	2.3721	
6 N. F.	a. 2.4799	2.4800	.0009
	b. 2.3281	2.3289	
6 F.	a. 2.3190	2.3197	
	b. 2.4613	2.4618	.0006

While the above experiment should not be considered as representing the possible deportment of frozen arsenates of lead under orchard conditions, nevertheless it would appear from these preliminary experiments that the adhesive properties of certain arsenate pastes are affected by freezing.

[1] This type of arsenate is treated with a fatty material with the view of "waterproofing" the dried spray in order that it will not be washed from the leaf by rain.

Micro-photographs taken of samples 1, 3, and 6 indicate that the particles of the frozen arsenates are uniformly larger than those of the unfrozen arsenates. Figures 5 and 6 of Plate 46 show samples 1 N. F. and 1 F. as they appeared when sampled with a tube during agitation of the solution. The particles of frozen arsenate are much larger and because of this it is difficult to get an even "spread" of suspended material.

Figures 7 and 8 representing samples 3 N. F. and 3 F. (stearated) also show the increase in size of particles after freezing.

Figures 9 and 10 representing samples 6 N. F. and 6 F. also indicate that although the settling properties of the arsenates are unaffected by freezing, the physical properties of the particles are greatly altered. What effect this change will have upon the adhesive properties of the arsenates of lead when sprayed under ordinary conditions is not known. The chemical and physical properties of the unfrozen and frozen lead arsenate pastes will be studied in this laboratory and their insecticidal efficiencies will also be compared.

In conclusion the writer wishes to acknowledge his indebtedness to Professor A. L. Lovett who obtained the opinions of specialists in this field, and also to Professor John Fulton and Professor S. H. Graf for assistance in photographic work.

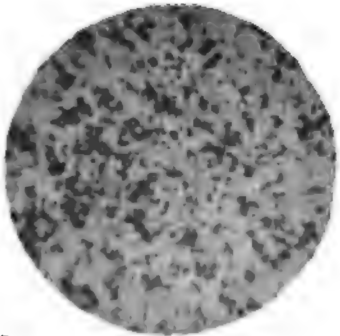
Conclusions

1. The settling properties of some commercial samples of lead arsenate paste are affected by freezing while others are not.
2. The microscopical appearance of all lead arsenate pastes examined were altered.
3. The adhesive properties of lead arsenate pastes may be affected by freezing.

AN INDIAN ANT INTRODUCED INTO THE UNITED STATES

By William Morton Wheeler

During the past summer while helping Mr. S. A. Rohwer to arrange the Pergande collection of ants recently acquired by the United States National Museum, I found a series of workers of a common Indian ant, *Triglyphothrix striatidens* Emery, that had been taken August 14, 1913, by Mr. E. R. Barber at Audubon Park, Louisiana. As this interesting insect has only recently spread from its original home in Southern Asia and has not been previously recorded from the United States, it seems advisable to publish a description and simple drawing of it and to trace its history in myrmecological literature.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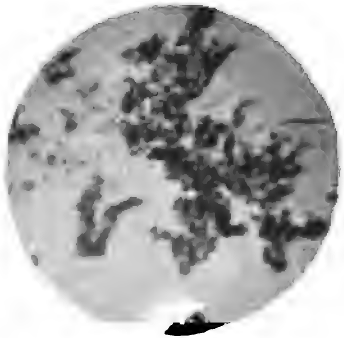
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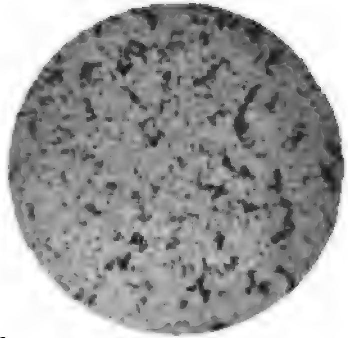
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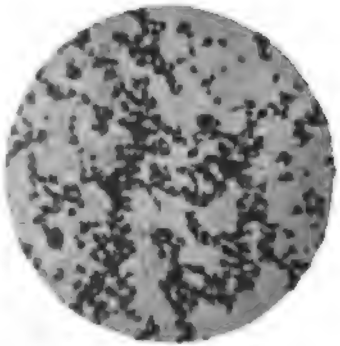
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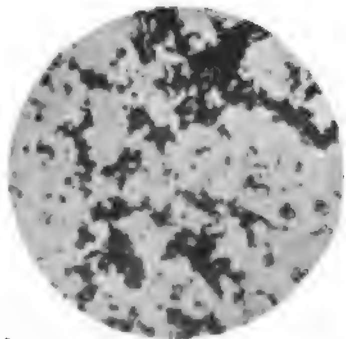
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The genus *Triglyphothrix* Forel is exclusively palæotropical and comprises some twenty described species, about evenly divided between tropical Africa and the Indomalayan region. *T. striatidens* was first described from Burma by Emery in 1889 as a subspecies of *T obesa* Ern. André and was cited for some time under this name by both Emery and Forel. Later it was given specific rank. Bingham, who found it common and widely distributed in India, Ceylon and Burma, claimed that it "differs constantly both in Indian and Burmese specimens" from *obesa*, but the differences are not very striking and seem not to be constant.

The contention that *striatidens* originated in Southern Asia is, of course, based on its abundance in that region. Its tendency to spread into other tropical and subtropical portions of the Old World was first noticed by Emery, who in 1891 recorded it from Tunis and stated that Ern. André had recently received it from Sierra Leone. In 1901 Forel recorded it from the Bismarck Archipelago and in 1902 from Australia, where it was taken by Turner near Mackay, Queensland. Forel described this form as a distinct variety, *australis*, although it differs only slightly if at all from the typical Indian form. That it is still very rare or local in Australia is indicated by my inability to find it in Queensland or in the large collections of ants sent to me from this and other portions of the commonwealth. In 1909 I recorded the occurrence of *T. striatidens* in Formosa, where it was taken by Mr. Hans Sauter. In 1912 Stitz described from the Island of Ceram as *T. ceramensis*, which, to judge from the description, is hardly more than a variety of *striatidens*. In 1913 Forel cited *striatidens* from Sumatra, where it was taken by von Buttel-Reepen. I find in my collection a single typical worker taken at Kuching, Borneo, by Mr. J. Hewitt and a deälated female taken by Mr. D. T. Fullaway on the Island of Guam.

When common tropical ants begin to spread beyond their native environments, they are very apt to be introduced with plants into the hot-houses of temperate regions. As early as 1906 Bingham found *T. striatidens* in the propagating pits of the Kew Botanic Garden, in England, and in 1905 and 1908 Dornisthorpe recorded it as common in the Palm House of the same institution.

Forel was the first to notice that *striatidens* had been transported and had secured a foothold in the New World. As early as 1900 he received specimens of a small variety which he called *lævidens*, that had arrived at Hamburg from Mexico in a living condition with orchids, and more recently (1912) he announced the occurrence of the typical *striatidens* in Barbados. In 1902 and 1911 he stated that this ant was actively "becoming cosmopolitan." Mr. Barber's specimens show that it has now made its appearance in the Southern States.

It may, therefore, be expected to take up its residence at no remote date in the hot-houses of the northern states. In all probability it has already established itself in numerous localities in tropical America, from which orchids and other plants are being constantly imported.

The worker *T. striatidens* (Fig. 39a and b) is very easily distinguished from that of any of our American ants by the shape of the head and thorax and the peculiar structure of the soft, dense, erect hairs covering the body. It measures only 2.5 mm. and is orange-brown or dark brown with the first gastric segment blackish and the mandibles, antennæ and legs brownish-yellow. The mandibles are striated, the head, thorax, petiole and postpetiole subopaque, punctate and reticulate-rugose, the rugæ on the upper surface of the head being longitudinal. The gaster is smooth and shining. The head is subrectangular,

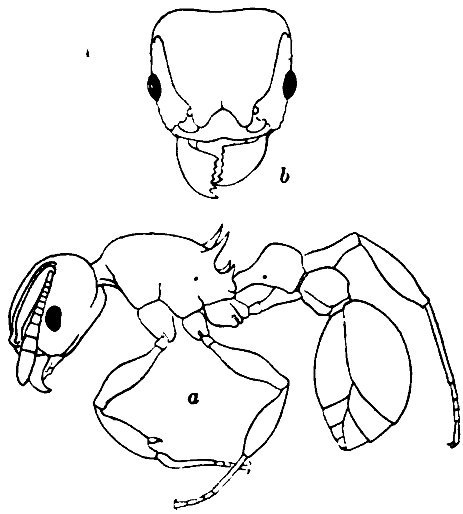

Fig. 39. *Triglyphothrix striatidens* Emery, *a* worker in profile; *b* head from above.

with the frontal carinæ continued backward nearly to the posterior corners and forming the inner borders of broad and moderately deep scrobes into which the folded antennæ fit above the eyes. The thorax is short, without promesonotal and mesoëpinotal sutures, with the episternal angles projecting upward as spines and the epinotal spines rather long, erect, pointed and very slightly recurved. The nodes of the pedicel are somewhat flattened above, the petiole is anteriorly pedunculate, its node a little longer than broad, the postpetiolar node is rounded, about as broad as long, shorter than the petiolar node. The body and legs are covered with soft, dense, erect hairs, many of which are trifid from their insertions and therefore suggested the generic name The female is a little larger than the

worker, but very similar, apart from the usual differences in the structure of the thorax, presence of ocelli and wings. The male is still unknown.

The following literature contains all or nearly all the important references to *T. striatidens:*

1903. BINGHAM, C. H. The Fauna of British India including Ceylon and Burma Hymenoptera II, 1903, p. 173. (Description of *T. striatidens* and other Indian species of the genus.)

1906. BINGHAM, C. H. The Wild Fauna and Flora of the Royal Botanic Garden, Kew. Bull. Misc. Inf. Roy. Bot. Gard. Kew. Add. Ser. 5, 1906, p. 28. (*T. striatidens* in propagating pits at Kew.)

1908. DONISTHORPE, HORACE. Additions to the Wild Fauna and Flora of the Royal Botanic Gardens, Kew 7. Bull. Misc. Inf. Roy. Bot. Gard. Kew, 1908, p. 122. (*T. striatidens* in fern and palm houses at Kew.)

1915. DONISTHORPE, HORACE. British Ants, Their Life-History and Classification. Plymouth, Wm. Brendon & Co., 1915, p. 341. (*T. striatidens* common in Kew Gardens.)

1889. EMERY, CARLO. Formiche di Birmania e del Tenasserim raccolte da Leonardo Fea (1885–87) Ann. Mus. Civ. Stor. Nat. Genova (2) 7, 1889, p. 501. (Original description of *T. striatidens.*)

1891. EMERY, CARLO. Revision Critique des Fourmis de la Tunisie. In Explor. Sc. Tunisie 1891, p. 4. (*T. striatidens* recorded from Tunis and Sierra Leone.)

1900. FOREL, A. Fourmis Importees. Bull. Soc. Ent. Suisse 10, 1900, p. 284. (*T. striatidens* var. *lævidens* imported into Hamburg from Mexico with orchids.)

1901. FOREL, A. Formiciden aus dem Bismarck-Archipel. Mitth. Zoöl. Mus. Berlin, 2, 1901, p. 10. (*T. striatidens* in Bismarck Archipelago.)

1902. FOREL, A. Fourmis Nouvelles d'Australie. Rev. Suisse Zoöl. 10, 1902, p. 449. (*T. striatidens* var. *australis* described from Queensland.)

1902. FOREL, A. Les Formicides de l'Empire des Indes et de Ceylan. Pt. X. Journ. Bombay Nat. Hist. Soc. 14, 1902, p. 704. (*T. striatidens* recorded from Burma, Ceylon and "tout le continent de l'Inde. Cette espèce tend a devenir cosmopolite.")

1902. FOREL, A. Myrmicinæ nouveaux de l'Inde et de Ceylan. Rev. Suisse Zoöl. 10, 1902, p. 239. (*T. striatidens* subsp. *orissana* described from Orissa.)

1911. FOREL, A. Apercu sur la distribution géographique et la phylogénie des Fourmis. 1e Congr. Internat. d'Ent. Bruxelle, Aug. 1910, 2, 1911, p. 83. (Cosmopolitan distribution of *T. striatidens* mentioned.)

1912. FOREL, A. Formicides Neotropiques. Part IV. Mem. Soc. Ent. Belg. 20, 1912, p. 1. (*T. striatidens* in Barbados.)

1913. FOREL, A. Ameisen aus Sumatra, Java, Malacca und Ceylan, Gesammelt von Herrn Prof. Dr. von Buttel-Reepen in den Jahren 1911–1912. Zoöl. Jahrb. Abth. f. Syst. 36, 1913, p. 82. (*T. striatidens* in Sumatra.)

1909. WHEELER, W. M. Ants of Formosa and the Philippines. Bull. Amer. Mus. Nat. Hist. 26, 1909, p. 336. (*T. striatidens* in Formosa.)

Scientific Notes

The Velvet Bean Caterpillar. The velvet bean caterpillar has damaged thousands of acres of velvet beans in Florida during the past month, and little effort has been made by the farmers to control it. The so-called "cholera" (*Botrytis rileyi*) is now becoming effective in the field and will probably kill 90 to 95 per cent. of the caterpillars, as it does about this time each year.

R. N. Wilson.

Alfalfa Caterpillar. The most notable recent damage caused by insects in Southern Arizona was that of the alfalfa caterpillar, *Eurymus eurytheme*. The worms were especially numerous, and had it not been for a contagious disease which finally brought it under control, the damage would have been much more severe than it was. Irrigation of certain fields proved at this time to be an almost certain check upon the outbreak, since the added moisture was conducive to the further development of the disease, and the worms died within a few days after the water was applied.

V. L. Wildemuth.

A Plague of Leaf-Hoppers. On the evening of August 30 the city of Columbia, S. C., and suburbs were visited by myriads of leaf-hoppers belonging to the species *Draeculacephala reticulata*. These "hoppers" were so abundant on the main thoroughfare in the city as to cause very much annoyance to pedestrians. Offices, restaurants, ice-cream parlors and moving-picture houses were infested and some of them were forced to close up for the night. A band that was playing on the top of an eleven-story building was compelled to quit for the evening. On the following night the leaf-hoppers were again present but in small numbers.

P. Luginbill.

Moving Lights Versus Stationary Lights in Phototropism Experiments. Recently, the writer had the opportunity of witnessing the operation of a machine designed to capture the adults of injurious species of insects. A light was used to attract the insects, and on flying near the burner a powerful suction of air created by a gasoline engine whirled them into an inner chamber with such force as to kill the softer ones and cripple the harder species such as beetles and grass-hoppers. The machine was mounted on a truck which was drawn along the edges of the fields of a sugar plantation. Whether it is really efficient has not been determined, and as it is not now being operated there has been no further opportunity to observe it in action.

It was noted that considerable numbers of moths of *Diatraea saccharalis* and *Laphygma frugiperda*, especially gravid females, were attracted by the light. As these species are seldom found at trap lights which have been operated at Audubon Park for several years, it would seem that there must be a difference between these lights and the light used in the machine. As lights of various intensities and colors have been tried at Audubon Park, however, the writer believes that the difference lies not in the lights themselves but in the fact that the lights at the Park are stationary while the light on the machine is moved about from place to place among the fields and thus attracts one group of insects after another. In fact, the attraction of group after group could very readily be noted. When the insects were abundant the truck was stopped for one or two minutes, and when the cloud of insects had disappeared, either settling again or being sucked into the machine, the mules were started and the machine was driven a few yards further on. Possibly the mere motion of the light exercised some attraction which stationary lights do not possess. Other possi-

ble factors are the noise of the gasoline engine and the walking of the mules and operators of the machine through the grass, the noise and the general disturbance probably causing more insects to fly than would have been attracted solely by the light.

T. E. HOLLOWAY

On the Distribution of the Imported Cabbage and Onion Maggots.[1] In recent publications, *e. g.*, one published this year,[2] the authors state in regard to the imported cabbage maggot, "According to published statements it has now spread throughout the United States and Canada, and caused injury wherever its food plants are grown. Some entomologists, however, consider this questionable and regard another species, *Pegomya fusciceps* Zett., which is a general feeder, as responsible for the injury in the Southern Atlantic States."

This remark requires a little elucidation. For many years entomologists and others have reported the cabbage maggot and the onion maggot as occurring in Texas and other Gulf States, whereas these species are not known to occur there but are represented by the related seed-corn maggot (*Pegomya fusciceps* Zett.). This last species is generally distributed in the United States, and is often concerned in injury to cabbage and onion where the true cabbage maggot (*Pegomya brassicæ* Bouché) and the important onion maggot (*P. cepetorum* Meade) are generally believed, or have proved to be, the principal enemy. Considerable has been written on this topic, and the main purpose of this note is to call attention to the fact that the true cabbage maggot positively does not occur, permanently at least, south of New Jersey so far as we can learn, and is somewhat limited, if not entirely so, to the more northern portion of that state, if, indeed, it occurs at all south of the middle of that state. From that point southward it is replaced by the seed-corn maggot which does considerable damage to vegetables and other plants grown in that region.

It may be remarked at this point that the imported onion maggot has about the same distribution as the cabbage maggot, and when the onion maggot and the cabbage maggot are reported from the South, it is the seed-corn maggot which is actually doing the damage.

This opinion is based on specimens which have passed through the writer's hands for a period of years, and have either been identified or the identifications confirmed by such authorities as Coquillett, Walton, and F. R. Cole. The different species are not so difficult to determine provided both sexes, especially the males, are properly mounted.

F. H. CHITTENDEN, *Bureau of Entomology, United States Department of Agriculture.*

[1] Published by permission of the Secretary of Agriculture.

[2] See Britton, W. E., and Lowry, Quincy S., Insects Attacking Cabbage and Allied Crops in Connecticut. Conn. Agr. Exp. Sta. Bul. No. 190, Jan., 1916, Entom. Ser., No. 25, p. 3, and others.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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Every working scientist appreciates the value of a comprehensive bibliography or index along his special lines. Entomologists have been admirably served in this respect, up to recent years, by the *Bibliography of American Economic Entomology*—a series of publications covering the period to the end of 1904. The decade following has been provided for by the as yet unpublished *Index of American Economic Entomology*, a work which will not appear till at least two years have elapsed subsequent to the period covered. Such a work is valuable in proportion to its completeness *and timeliness*. It is unfortunate that it could not have been published earlier. The Index will doubtless be published soon and unless the matter receives due attention, we may have a similar experience in relation to an Index covering the next five- or ten-year period—two years of which have practically elapsed. The work is too useful to be dropped and it should be so complete and comprehensive as to make unnecessary the compilation of minor special indexes which are to be found in many entomological offices. Moreover, each number should be issued within six months of the end of the period covered. It is entirely feasible to attain these ends, if it is considered worth while. The writer is of the opinion that more effort has been expended and is being given to special indexes of very limited availability than would be necessary to produce a compilation equally valuable to the specialist and, through early publication, of incalculable assistance to all. We are still of the opinion that the federal government would render a most valuable service to applied or practical entomology by continuing the series

and if this is impractical, as appears to be the case, could the Association of Economic Entomologists undertake a more useful and appropriate work than providing for the preparation and early publication of comprehensive indexes to the rapidly increasing and widely scattered literature of American Economic Entomology?

Review

Rhynchophora or Weevils of North Eastern America, by W. S. Blatchley and C. W. Leng. The Nature Publishing Company, Indianapolis, 1916, pp. 1–682, figs. 154.

Another beetle book has made its appearance, being a supplement to Professor Blatchley's Coleoptera or Beetles of Indiana which was published in 1910. It is not restricted to Indiana, however, but covers, as indicated by the title, the entire eastern portion of the United States and Canada. Much attention has been given to the Rhynchophora, and many new genera and species have been described since the work published by LeConte and Horn in 1876, which is not only out of date but out of print and the present publication brings the classification to the present. The primary object of the authors is to furnish a standard work on the Coleoptera for the student which will enable him to classify and identify weevils. While the work is necessarily technical, many matters relating to synonymy and other more strictly technical matter have been omitted, and the work has been simplified to meet these requirements. Synopses of families, genera, species and other subdivisions form an important portion of this work, and where these synopses are sufficient for identification detailed technical descriptions are omitted. Other valuable features of the publication are notes on distribution and food habits, the latter particularly being credited to authoritative observers and specialists. A distinct departure from other works of this nature consists in longer accounts of species of economic importance, with summarized life-histories, and indications of the principal methods of control. The authors have had the advantage of coöperation on the part of many specialists, which also adds much to the value of the work. The same is true of the explanation of structures used in the classification of this group. Four families are represented: Brenthidæ, Anthribidæ, Curculionidæ, and Scolytidæ. The work will be needed by all students of Coleoptera, by experiment station and other practical workers, and those engaged in teaching entomology. The authors deserve great credit for their careful painstaking work which has covered, without doubt, the labors of several years. The volume concludes with an excellent and very complete bibliography, systematic, biologic, and economic; a plant and generic index, as well as one covering the new genera and species described. (*Adv't.*)

F. H. Chittenden, *Bureau of Entomology, United States Department of Agriculture.*

Current Notes

Conducted by the Associate Editor

Mr. Christopher H. Roberts, a coleopterist and former president of the New York Entomological Society, died September 29.

Mr. G. H. Hecke has recently been appointed State Commissioner of Horticulture of California vice Dr. A. J. Cook, deceased.

Mr. E. L. Worsham, State Entomologist of Georgia, visited the Bureau of Entomology, Washington, D. C., on September 25.

The members of the Federal Horticultural Board recently visited the fumigation plants located in Boston, Brooklyn and Newark.

Mr. Frank H. Smith, Ohio State University, 1916, has been appointed teaching fellow in entomology at the Iowa State College.

Mr. Kennith Hawkins has been appointed by the Bureau of Entomology to take charge of extension work in beekeeping in the Southern States.

Mr. Louis H. Joutel, the well-known entomological artist of New York City, and former treasurer of the New York Entomological Society, died September 6.

Mr. George N. Wolcott has resigned as assistant entomologist of the Porto Rico Insular Station to complete his studies for a doctorate at the University of Illinois.

Mr. H. R. Hagan, instructor in entomology, Utah Agricultural College, has been granted leave of absence for the coming year to pursue graduate study at Harvard University.

Mr. Alfred Free Swain, formerly of Montana State College and of Stamford University, has been appointed assistant in entomology in the Graduate School of Tropical Agriculture of the University of California at Riverside, Calif.

Prof. H. F. Wickham, who has been temporarily attached to the Wellington, Kans., Laboratory of the Bureau of Entomology, has returned to his home at Iowa City to take up his regular work at the University.

Mr. G. C. Woodin, instructor in entomology, Michigan Agricultural College, and assistant in the Station, resigned October 1 to pursue graduate study at the Ohio State University. His address is 179 South Richardson Ave., Columbus, Ohio.

Mr. E. S. Tucker, formerly of the Louisiana Experiment Station, has been appointed a temporary field assistant of the Bureau of Entomology to determine the spread of the boll weevil in western Texas, and in Oklahoma and Arkansas.

Mr. H. C. Yingling, a graduate of the Ohio State University, has been appointed to an instructorship in the Department of Entomology of the Texas Agricultural and Mechanic College, College Station, Texas. Mr. Yingling entered upon his duties the first of October.

At the Maryland Agricultural College and Station, the following appointments have been made: Mr. C. J. Pierson, assistant in entomology and zoölogy in the College; Dr. Philip Garman, assistant entomologist in the Station; Mr. O. I. Snapp, fellow in insect investigations in College and Station.

Dr. E. F. Phillips, Bureau of Entomology, went to Chicago on October 23 to arrange for extension work, later going to Amherst, Mass., October 30, to consult the associate professor of beekeeping at the Massachusetts Agricultural College concerning future work on bee diseases.

Dr. G. F. White, Bureau of Entomology, has concluded his investigations of bee diseases and will be on furlough until April 1, 1917, at which time he will resume insect disease investigations and will be connected with the office of Cereal and Forage Insect Investigations.

Arrangements have been completed by the Bureau of Entomology for extension work in beekeeping in Tennessee in coöperation with the State College of Agriculture and Cyrus E. Bartholomew, formerly of the Iowa State Agricultural College, has been appointed to conduct this work, beginning November 1.

In the Bureau of Entomology Mr. E. L. Skellregg, Sandusky, Ohio, has returned to Amherst, Mass., and Mr. A. J. King, Vashon, Wash., to the University of Washington, for further study. Mr. Irving R. Crawford, temporarily attached to the Wellington, Kans., field station, has also returned to his studies.

Professor H. E. Summers, of the Iowa State College, has improved much in health and is working over some of his extensive collections in the Rhynchota. He expects to spend the winter months in the south, as he did last year, making collections and recuperating in health.

Mr. C. H. Richardson has resigned his position as assistant entomologist of the New Jersey Agricultural College Experiment Station and instructor in entomology in Rutgers College, to take up graduate study in the biochemistry of insects at Columbia University. His address is 1400 University Ave., New York City.

Dr. E. D. Ball, formerly director of the Utah Agricultural Experiment Station, has been appointed State Entomologist of Wisconsin, with headquarters at Madison, and has entered upon his duties. Dr. Ball takes the place of Mr. J. G. Sanders who recently accepted the position of Economic Zoölogist of Pennsylvania.

The following men have recently left the employ of the Bureau of Entomology: J. K. Primm, North East, Pa., and George R. Bailey, Gainesville, Fla., terms of appointment expired. J. G. Hester, Brownsville, Texas, H. L. Weatherby, Rocky Ford, Colo., J. I. Hambleton, Madison, Wis., Wm. N. Ankeny, Big Rapids, Mich., A. H. Robinson, Plymouth, Ind., resigned.

Dr. A. J. Cook, State Commissioner of Horticulture in California, died September 29 at 74 years of age. Dr. Cook was formerly professor of entomology in the Michigan Agricultural College, and for eighteen years was professor of biology in Pomona College at Claremont, Cal. For the past five years he has held the office of Commissioner.

Mr. Nathan Banks, for more than twenty years assistant entomologist in the Bureau of Entomology, has accepted the position of custodian of insects in the Museum of Comparative Zoölogy, Cambridge, Mass., the position formerly held by Dr. Hagen. Mr. Banks took his own library and collection to the museum where he entered upon his duties November 1.

Mr. F. C. Craighead of the Bureau of Entomology is making a preliminary study of a trouble affecting the oaks in the South Atlantic and Gulf States. The exact

cause of the trouble is not known but it appears to be a combination of *Prionus* affecting the roots, and *Agrilus bilineatus* and *Pityophthorus pruinosus* in the trunks and branches.

Mr. Geo. H. Rea, former state inspector of apiaries in Pennsylvania, has been appointed agent to conduct the extension work in beekeeping in North Carolina for the Bureau of Entomology in coöperation with the North Carolina College of Agriculture and Mechanic Arts, Raleigh. He will be under the administrative supervision of the State Entomologist, Franklin Sherman, Jr. Mr. Rea spent a few days in Washington and left for North Carolina on September 18.

A new greenhouse is now being built for the branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology. It is modeled after the first one constructed for this branch of the Bureau in 1914, and it is to be used for fumigating different forms of insects affecting cucumber and related plants, tomatoes, lettuce, beans and other truck plants grown under glass under different conditions of light, moisture and temperature.

The following men in the Bureau of Entomology have recently been transferred to other work or localities: A. J. Flebut, Southern Field Crop Insect Investigations, to take up work on the chestnut weevils; A. G. Webb, Boston, to Minnesota; H. W. Willis, Newark, N. J., to Brooklyn, N. Y.; Dr. Henry Fox, Charlotteville and Tappahannock, Va., to Clarksville, Tenn.; E. H. Gibson, Mo., to Washington, D. C.; George W. Barber, Maxwell, N. M., to Wellington, Kans.; H. B. Scammell, Brown's Mills, N. J., to Toms River, N. J.; D. G. Tower, Office of Tropical and Subtropical Insect Investigations, to Federal Horticultural Board and stationed at the Port of New York; W. E. Dove, Aberdeen, S. D., to Dallas, Tex.; D. G. Caffrey, Maxwell, N. M., to Tempe, Ariz.; C. F. Turner, Greenwood, Miss., to West Lafayette, Ind.; J. M. Langston, Greenwood, Miss., to Forest Grove, Ore.; C. M. Packard and T. D Urbahns, Pasadena, to Martinez, Calif.

During October a distinguished party of South Carolinians visited Louisiana and parts of Mississippi for the purpose of obtaining first-hand information regarding the boll weevil. The party was headed by Governor Manning and included the president of the Agricultural and Mechanical College, the director of the Experiment Station, and chairman of the Board of Trustees of Clemson College, and representatives of the State Bankers' and Cotton Seed Crushers' Associations, and several others. It was accompanied throughout its trip by W. D. Hunter. The party made a thorough study, especially with reference to the steps which can be taken in South Carolina, to avoid the losses and demoralizations which have practically invariably followed in the wake of the boll weevil. It is anticipated that the full report of the Commission, which is to be written by Dr. Riggs, president of Clemson College, will be an historic document.

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